(Rack-mount version shown)

# F600 Precision AC Thermometry Bridge

## User Manual – Issue 2.9

This manual supersedes all previous versions – please keep for future reference


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|---|---|
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# Conventions used in this manual

## Structure of manual

The manual is divided into sections. Each section deals with a specific topic or related topics. Sections are displayed in a regular, bold typeface, for example - **1.0 Introduction**. Sections are sub-divided into sub-headings, for example - ***1.1 Features***. These may also be subdivided.

## Terminology

The terms F600AC Precision Bridge, AC Bridge, F600, F600AC, precision bridge, bridge and instrument are used interchangeably in this manual.

## Warnings and Notices

These appear in the body of the text, clearly displayed with a box surrounding the text. The first word within the box displays the type - **Warning** or **Note**.

A **Warning** (double box) is designed to draw attention to an aspect that may cause danger to the user or damage to the instrument. A **Note** (single box) is used to bring special attention to something important requiring action or avoidance.

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# Important safety information

Read and understand the user instruction manual before attempting to use the instrument.

The F600AC is a precision AC bridge. It must not be used for any other purpose.

**Warning**

The protection provided by the instrument may be impaired if the equipment is not used in the manner specified.

Only replace items or components with an approved or equivalent spare part. All spare and consumable parts are available from ASL.

**Warning**

The instrument is NOT designed to be used in a potentially explosive atmosphere or medical environment.

- × Do NOT clean the instrument with solvents
- × Do NOT insert objects into openings
- × Do NOT place the instrument onto a hot or cold surface
- × Do NOT place any weight on top of the instrument

- ✓ Do use the correct USB lead supplied

**Warning**

The outer conductor of the BNC connectors and the cable braid are not at earth potential and should not be earthed.

**Warning**

Do NOT open the case. There are no user serviceable parts inside.

**Warning**

Inspect cables and probes regularly, ensuring that their insulation is not damaged.

**Warning**

The instrument and the internal Li clock battery must be disposed of in accordance with local regulations.

**General warning symbol**. This indicates that a hazardous condition or general danger may exist. **You must read the relevant sections in the User Manual before using the instrument.**

**Refer to manual symbol**. When you see this symbol on the instrument it means that there is more information relating to this in the User Manual.


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# Important installation information

Please ensure that the instrument is installed correctly.

- × Do NOT use the instrument near water or in damp conditions
- × Do NOT locate the instrument near a source of heat
- × Do NOT insert objects into any ventilation openings
- × Do NOT site the instrument in a draught or near an air-conditioning unit
- × Do NOT site the instrument near any strong magnetic fields

- ✓ Locate the instrument on a suitable and secure surface
- ✓ Ensure air can freely circulate around the instrument

The instrument uses a universal input voltage power supply. Use a plug to connect to the mains supply. If in doubt, consult a qualified electrician. The supply connections are shown below (if a UK cord set is fitted).

| | | | |
|---|---|---|---|
| Brown wire | to Live (Line) | - | L |
| Blue wire | to Neutral | - | N |
| Green and Yellow wire | to Earth (Ground) | - | E |

**Warning**

The instrument is designed to be connected to the mains supply via a plug and must be effectively earthed.

# Important probe safety information

Care must be taken with probes used with the instrument. The following safety information must be observed.

- × Do NOT attempt to lift the F600 by any of the leads

- ✓ Do ensure that long probe-leads are kept away from areas where people could trip over them or become tangled in them
- ✓ Do ensure the probe-leads are kept in good condition

**Warning**

Because of the nature of the instrument, probes can be excessively HOT or COLD during use. Take suitable precautionary measures when handling probes.

Take care that you (and other people working in the same area) do not come into contact with the metallic probe or the insulating sheath near the probe, which will also be hot/cold.

Precautions apply both during use or when moving the probe from one position to another.

**Warning**

Probes may be immersed in various chemicals during use. Some of these chemicals may be dangerous or harmful (even when the probe is cold).

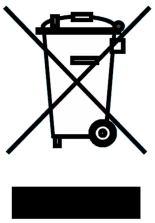
Always assume that the probe has been used this way and DO NOT touch the probe without suitable protective clothing.

**Warning**

DO NOT allow the probe to touch any external voltages such as MAINS power.

# Important disposal information

If you are responsible for disposal, then please note that this product may contain materials that are regulated in their disposal due to environmental considerations. The presence of these materials is consistent with global regulations applicable at the time this product was placed on the market.



## European Union

This symbol means that the product to be disposed of should not be mixed with commercial or general household waste. Used products must be treated separately in accordance with legislation that requires the proper treatment, recovery and recycling of the product.

If you wish to discard the product, then please contact your dealer, supplier or representative who will advise the correct procedure for disposal.

Disposing of the product correctly will help to save valuable resources and prevent environmental damage.

## Outside the European Union

The symbol only applies within the European Union. If you need to discard the product, then please contact your dealer, supplier or the local authorities and ask for the correct method of disposal.

## Battery

The F600 contains a small lithium button-cell that can be removed from the main control PCB. This battery must be disposed of in accordance with local regulations.

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# 1. Introduction

## 1.1 Overview

The F600AC Precision Thermometry Bridge is a high precision instrument designed for laboratory, commercial and industrial temperature measurement and calibration applications.

The F600AC Bridge operates with all 4-wire Platinum Resistance Thermometers (PRTs).

Features include –

- Immunity to most sources of errors present in DC Bridges
- Internal or external reference resistors
- A large graphic VFD display for excellent viewing of measurement values and instrument settings
- USB communication interface as standard for automated monitoring and calibration applications
- Calibration against traceable external standards
- User selectable units –- ratio, resistance or temperature display (Ω, °C, °F or K)
- Wide operational range to include all 4-wire thermometers with $R_0$ values from 0.25 ohms to 4,999 ohms[1]
- Rack-mount option (shown on front cover)
- Expandable to allow multi-channel input multiplexing
- Up to 99 probe calibration configurations
- Up to 99 channels (instrument setup configuration)

Overall system accuracy depends on the reference resistor quality and calibration - see the specification section. Resistance ratio measurement accuracy is better than ±2ppm (at 20°C ±2°C), equivalent to a temperature measurement precision of ±0.5mK.

[1] Depends on $R_s$ and current values.

## 1.2 Definitions and terminology

i. 0 °C = 273.15 K

ii. 1 mK (milli-kelvin) = 0.001 °C (one milli-degree Celsius)

iii. 1 milli-degree C = 0.001°C = 1m °C = 1mK = 1.8m °F

iv. 1 milli-degree F = 0.001°F = 1m °F = 0.56mK = 0.56m °C

v. Alpha (or $\alpha$) is the temperature coefficient, or temperature sensitivity, of the platinum wire used in PRTs. In general, the higher the alpha value, the better the PRT thermometer measurement reproducibility, stability and performance'

vi. Abbreviations for platinum resistance thermometers include –

PRT (Platinum Resistance Thermometer)

Pt100 (PRT with nominally 100 Ω resistance at 0 °C)

RTD (Resistance Temperature Device)

vii. System accuracy refers to the overall, combined accuracy of the F600 and thermometer.

## 1.3 Principles of measurement

The F600AC Bridge measures the voltage ($V_t$) developed across the unknown sensor resistance ($R_t$) and the voltage ($V_s$) across a stable internal (or external) reference resistance ($R_s$). The voltages are proportional to the resistances so the thermometer resistance is derived from –

$$R_t = R_s \times \frac{V_t}{V_s}$$

This technique achieves immunity from slow moving time and temperature drifts in the electronics as it is not affected by voltage measurement gain variations or current source fluctuations. In addition, the AC Bridge technique used achieves superior stability performance (over DC Bridges) by eliminating all other sources of thermally generated EMF's (voltages) and sources of drift – see appendix 5 for a brief description of AC bridge operation.

The reference resistor may be either one of the internal resistors (fitted as standard) or a reference resistor connected to the external $R_s$ ports. Either way, the resistor must have a known (calibrated) value for an accurate determination of the thermometer resistance $R_t$.

When using PRTs, the relationship between resistance and temperature varies slightly from one PRT to another. Therefore, no matter how accurately the F600 measures the PRT resistance, if the relationship between resistance and temperature for a particular PRT is not known, accurate temperature measurement is not possible.

The F600 uses PRT calibration data to overcome this problem and calculates the temperature from conversion functions using calibration data stored in the F600's internal non-volatile memory. This method enables the F600 to convert ratio to temperature, uniquely for each sensor used. Applications requiring multiple thermometers may store up to 99 sets of calibration data in the instrument.

It is very important, therefore, that a sensor is used on a properly configured input channel and that the probes' coefficients are correctly entered into the instrument.

**Note**

Always check that the coefficients are correctly set for the probe being used. Failure to do so, will almost certainly lead to incorrect measurements.

System accuracy is a combination of the Bridge's accuracy in measuring the probe resistance to reference resistance ratio and the calibration uncertainty placed on reference resistors and PRTs by the calibrating laboratory.

## 1.4 Balance readings

The F600 only displays balanced readings, unlike some previous AC bridges (e.g. F300) that output values all the time. This means that when the temperature that changes quickly, the bridge will not output a value until it is balanced.

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# 2. Setting up the F600

## 2.1 Safety information

Please read the safety information section before attempting to operate the F600.

## 2.2 Unpacking the instrument

When you unpack the F600AC Bridge, check that the following items are present before using the instrument[2] –

- F600AC precision thermometry bridge
- Operator's handbook on CD
- Test certificate
- Mains lead
- USB lead

Please contact the ASL Technical Services Group immediately if any of these items are missing or damaged.

Please retain the packaging. In case of return, servicing or calibration, use the original packaging. Failure to do so may invalidate the warranty and/or incur additional costs outside the warranty period. Please contact your agent, dealer or supplier when the original packaging is unavailable.

## 2.3 Setting up temperature measurement

To enable accurate resistance to temperature conversion to be carried out by the instrument, PRT characterisation data is required for both –

- temperature conversion algorithm (DIN, CvD or ITS90), and
- temperature conversion algorithm coefficients

The probe conversion algorithm and its coefficients can be stored in the instrument's internal non-volatile memory. Each probe setting stores one set of PRT characterisation data; up to 99 settings can be stored.

[2] Thermometer probes and other accessories (if ordered) will be supplied separately.

Up to 99 channels can be stored for the instrument. Each channel contains a complete set of instrument set-up conditions; this saves the user from resetting the instrumental conditions every time a different set of operating conditions is required.

Set-up for the probe channels and calibration data is covered later in the manual.

## 2.4 Getting started

- Read the manual thoroughly before using the instrument
- Unpack the instrument and allow to thermally stabilise the first time before switching on (particularly if the instrument is cold)
- Connect a 100 ohm resistor (any type will do) to the Rt terminals as described in section 4
- Switch on, and start measuring the ratio without changing any of the settings[3]
- Change one setting at a time to familiarise yourself with each of the menus. Start with the alternative display functions described in section 5.1
- Next use the **Units** menu - and try changing to °C, K and ohms
- Check that the bridge is operating correctly by changing the balance mode to unity, then to zero and then back to normal balance mode (section 5.1)
- Follow this by systematically changing the other instrument settings. Remember to reset each change until you are familiar with the F600

[3] As supplied, the F600 will be set for this measurement using the internal 100 ohm reference resistor.

# 3. About the F600AC Precision Bridge

This section introduces the features and functions of the F600AC Precision Thermometry Bridge. Each of the F600 Bridge's features is explained in turn. Once the F600 has been set to your particular requirements, all the commonly used functions are available using single key-strokes.

## 3.1 The front panel

The front panel is shown below (figure 3.1) with the various controls and connections -

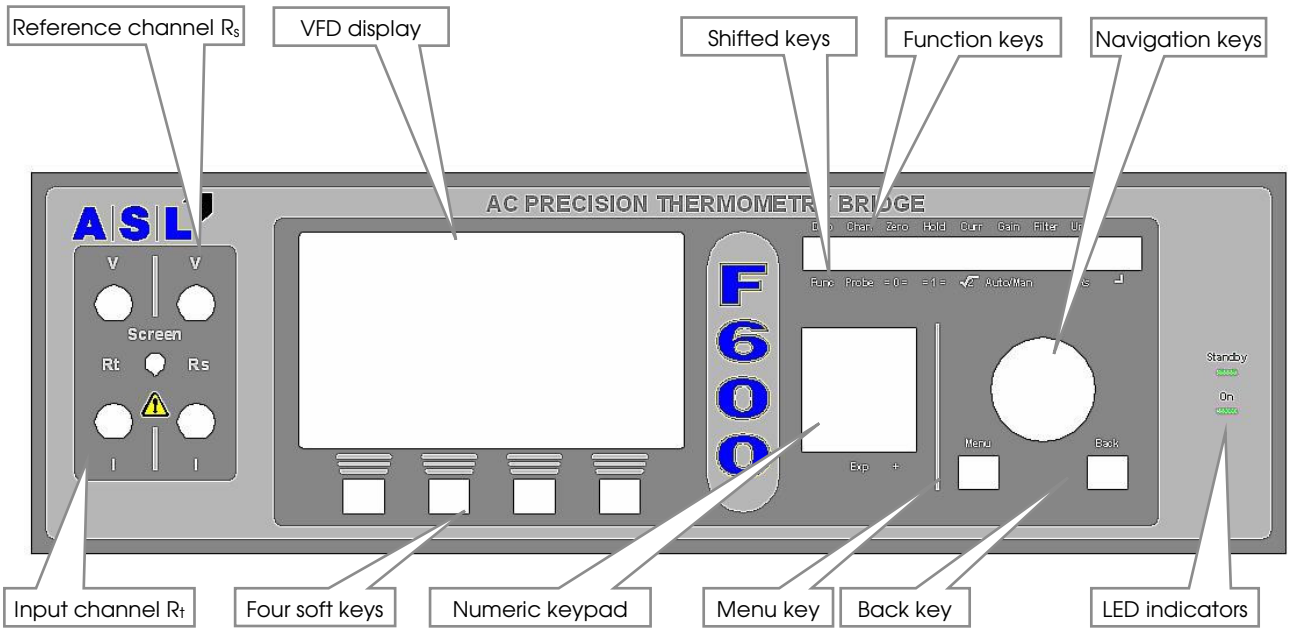



**Figure 3.1- front panel**

The graphical display is situated roughly in the centre off the instrument. The electrical input connections are situated to the left of the front panel. The two indicator LEDs to the right are used to indicate that electrical power is applied and to indicate that the bridge is in standby mode (graphical display in low power mode).

The various controls, connectors, displays and keys are described in detail in each of the following sections. The four keys under the display are 'soft-keys' so their function varies with the instrument operating mode (whenever these keys can be used, their current function is be displayed above each key).

## 3.2 About the VFD display screen

The large graphic VFD (Vacuum Fluorescent Display) screen is your direct link to the instrument, presenting you with the measurement results (and information relating to them) and also to the menus to set and control the instrument.

The VFD screen is designed for ant-reflective-viewing under normal ambient lighting. The VFD brightness may be set from the menu options (see section 5.3.7).

## 3.3 LED indicators

Two LEDs are situated to the right-hand side of the instrument.

### 3.3.1 Power LED

The lower (green) LED is illuminated when power is applied to the bridge and the bridge is switched on. The bridge should be switched off if it is not to be used for a long period of time.

### 3.3.2 Standby LED

The upper (orange) LED is lit whenever the bridge is in standby mode. In this mode, the VFD display is turned off, saving power and prolonging the display's life; the remainder of the electronics is powered normally during standby to ensure the instrument is stable and ready to use at a moments notice. See the section on the **Disp** function key for further details.

## 3.4 The keypad

The instrument's keys are grouped by type and consist of nine **Function** keys, a twelve key **Numerical** keypad, a **Navigation** and **OK** cluster of keys, four **Soft-keys**, and separate **Menu** and **Back** keys. The combination of **Function** and **Soft-keys** lets you choose how to access data and/or functions within the instrument.

The F600 keypad is shown in figure 3.1 and in more detail in figure 3.3. The keys are used to select the various menu options and to control the instrument. Generally, no more than one menu level is required for the commonly used settings. A few (infrequently used options) require two or three menu levels. Operation is very simple and straightforward once you are familiar with instrument. It may help to have the instrument to hand when reading through these sections.

The functions under the keys are accessed by pressing the right-hand MODE key and then the required key (e.g. to access the **Probe** menu press **Shift** and then the **Chan** key).

Refer to section 5 for a detailed description of how to use the keys to operate the instrument.

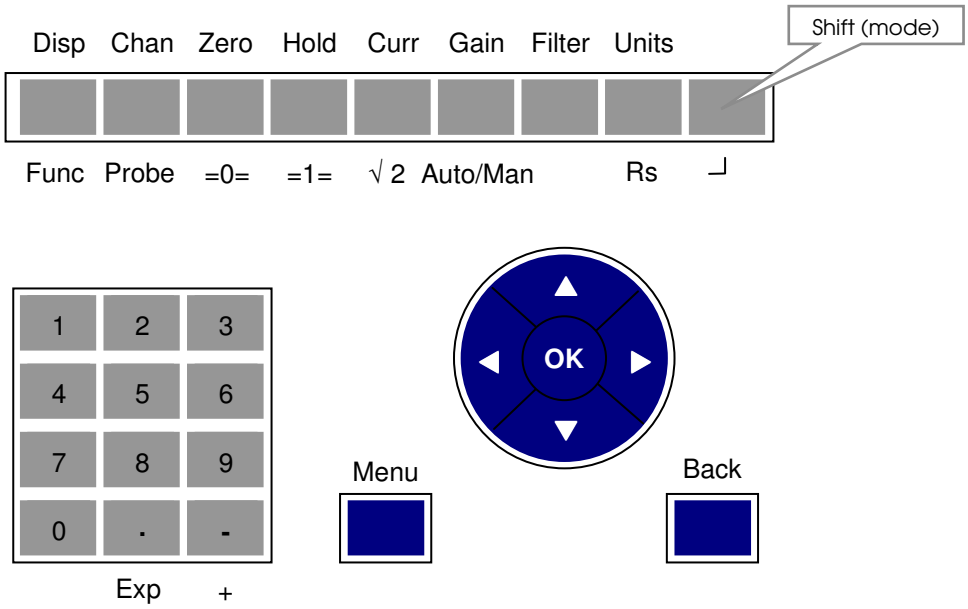



**Figure 3.3- keypad detail**

The keypad is used to select the various menu options and to set the operating modes. The commonly used keys are collected together in the top row. The functions under the top row of keys are accessed by pressing the mode key first and then the desired function key[4]. The numeric keypad used to enter numerical values (and may also be used to select sub-menu options when these are shown on the screen). The Menu key is used to select the remainder of the less frequently used options. The circular buttons are used to navigate through the menus. The Back key is used to return to the previous menu level without changing values.

A summary of the keys and their function is shown on the next page in table 3.1.

[4] Press the Mode key twice to return to normal, unshifted key operation.

| Instrument functions keys | | |
|---|---|---|
| **Key symbol** | **Description** | **Function** |
| **Disp** | Select display type | Alternates numerical, graphical, standby display |
| **Chan** | Select Input Channel | Opens and closes the $R_t$ /$R_s$ channel select menu |
| **Zero** | Zero display measurement | Opens and closes the display zero (null) menu |
| **Hold** | Hold display measurement | Starts and stops display (measurement continues) |
| **Curr** | Select operating current | Opens and closes the sensor-current menu |
| **Gain** | Select instrument gain | Opens and closes the instrument-gain menu |
| **Filter** | Select filter value | Opens and closes measurement-bandwidth menu |
| **Units** | Select display units | Opens and closes the display-units menu |
| **Shift (Mode)** | Shift key | Selects lower function keys (and Exp +) |

| Instrument functions shift keys | | |
|---|---|---|
| **Key symbol** | **Description** | **Shift + Function** |
| **Func** | Select function menu | Selects function menu |
| **Probe** | Select Probe menu | Opens and closes probe menu |
| **=0=** | Zero check | Selects zero check |
| **=1=** | Unity check | Selects unity check |
| **√2** | Set current | Sets root 2 current |
| **Auto/Man** | Set Auto/Manual balance | Selects auto or manual balance mode |
| **$R_s$** | Select Reference resistor | Opens the reference resistor menu |

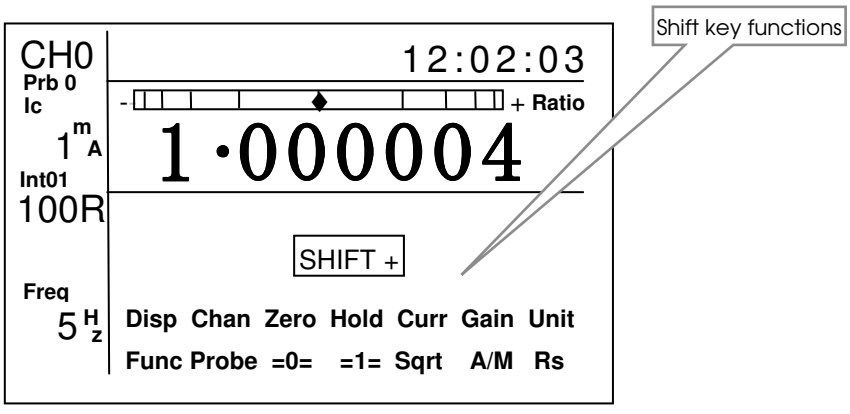
| Menu function keys | | |
|---|---|---|
| **Key symbol** | **Description** | **Function** |
| **Back** | Clear data entry/return | Clears any data entry errors or returns from a menu |
| **Menu** | Menu selection | Displays other sub-menus |
| ▲ ▼ ◄ ► | Arrow keys | Used to navigate through the menus |
| **OK** | Save entry | Saves data entry and returns to previous menu |

| Numeric keypad | | |
|---|---|---|
| **Key symbol** | **Description** | **Function** |
| **0 to 9** | Numerical data entry | Enters a numerical digit or selects a numeric menu |
| **-** | Minus key | Used during numerical data entry |
| **.** | Decimal point | Used during numerical data entry |

| Numeric shift keys | | |
|---|---|---|
| **Key symbol** | **Description** | **Function + Shift** |
| **Exp** | Exponent key | Used for numerical data entry (with the Shift key) |
| **+** | Plus key | Used for numerical data entry (with the Shift key) |

**Table 3.1 - summary of front panel key functions**

Press the **Shift** key (once) and the shift-key assignments will be displayed (shown below). Select the required function key (or press the **Shift** key once more to clear the display).



## 3.5 Input connectors

The BNC input connectors are located to the left of the display. The central connector is used when a screen connection is required. The two right-hand connections are only used when an external reference resistor is selected; they are not required when one of the internal reference resistors is used. The unknown resistance or probe is connected to the left-hand BNCs. Connections are described in detail in section 4.

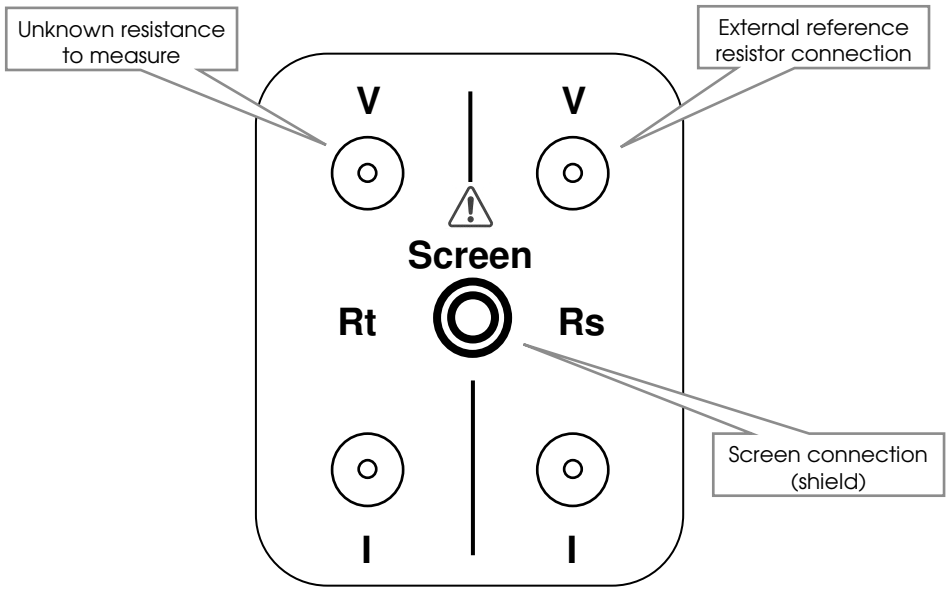



**Figure 3.4- input connections**

The inputs accept Passive probes. Passive probes do not contain calibration information and the F600 must be set-up with calibration information for each probe used (unless the calibration calculations are done externally). Up to 99 sets of probe information can be stored simultaneously in the F600 Bridge.

**Note**

It is good practice to switch off the bridge before changing resistors. This will prevent the resistors from experiencing any larger than normal currents.

## 3.6 Rear panel

The rear panel is shown below with the various items and connectors indicated.

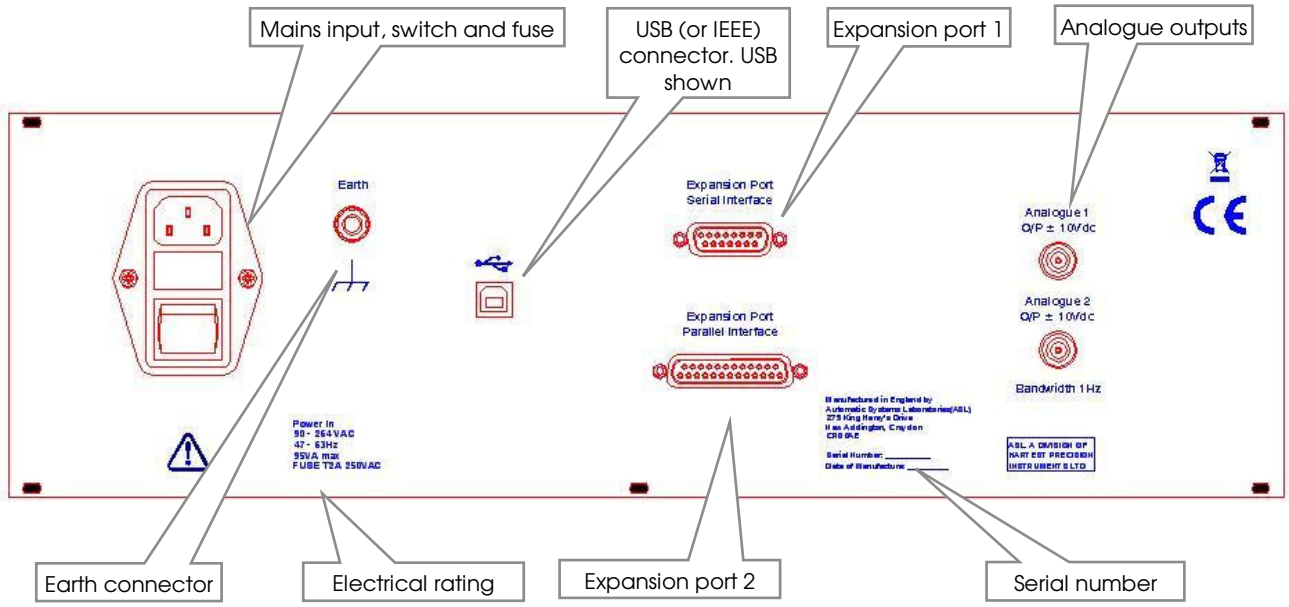



**Figure 3.4 - rear panel**

### 3.6.1 Name plate and serial number

The instrument's serial number is positioned here.

### 3.6.2 Electrical rating plate

The instrument rating information on the rear panel shows the instrument's input supply requirements, fuse value and maximum power consumption.

### 3.6.3 Mains input

The mains input connector is situated on the left of the rear panel. It uses a standard IEC connector and lead (supplied). The input connector has a switch and is fused. The fuse(s) are located within the body of the connector.

### 3.6.4 Expansion ports

There are two expansion port connectors provided on the rear panel. These connectors enable a multiplexer (purchased separately) to be used to expand the number of input connections.

### 3.6.5 Analogue outputs

There are two analogue outputs –

Output 1 - provides a scaled measurement[5] voltage (±10V)

Output 2 - provides a balance error signal voltage (±10V)

Output 1 may be used with a chart recorder. The output can be scaled and offset to provide a voltage proportional to the current reading over the range of interest.

Output 2 may be used to control an external process (the signal is proportional to the error between the $R_t$ input of the external process and the $R_s$ reference value).

### 3.6.6 USB Communication interface connector

The USB connector is fitted as standard (see figure 3.4). Communication requires the installation of the USB driver on a PC. See the separate information supplied on the CD. A standard USB cable is supplied with the instrument.

The instrument can be controlled through simple ASCII commands (see later section) and can transmit ASCII result-data, which may be recorded using a simple terminal program or using ASL's ULOG.

### 3.6.7 Earth connector

The earth connector on the rear of instrument is joined to the instrument's chassis and may be conveniently used to connect to other equipment (particularly if the instrument is rack-mounted).

[5] Units are selectable

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# 4. Sensor and reference resistor connections

The F600 Bridge is designed to operate with four terminal resistors or four terminal resistance thermometers and includes comprehensive guarding circuits.

Probe connection information is shown below. Two wire PRTs must be connected similarly to four-wire devices either at the sensor (preferred for accuracy) or at the input connector.

Since the measurement method relies on accurately measuring the ratio of two resistors, and since the bridge is limited to a 5:1 ratio, the measured resistor must not be greater than 5 times the value of the reference resistor.

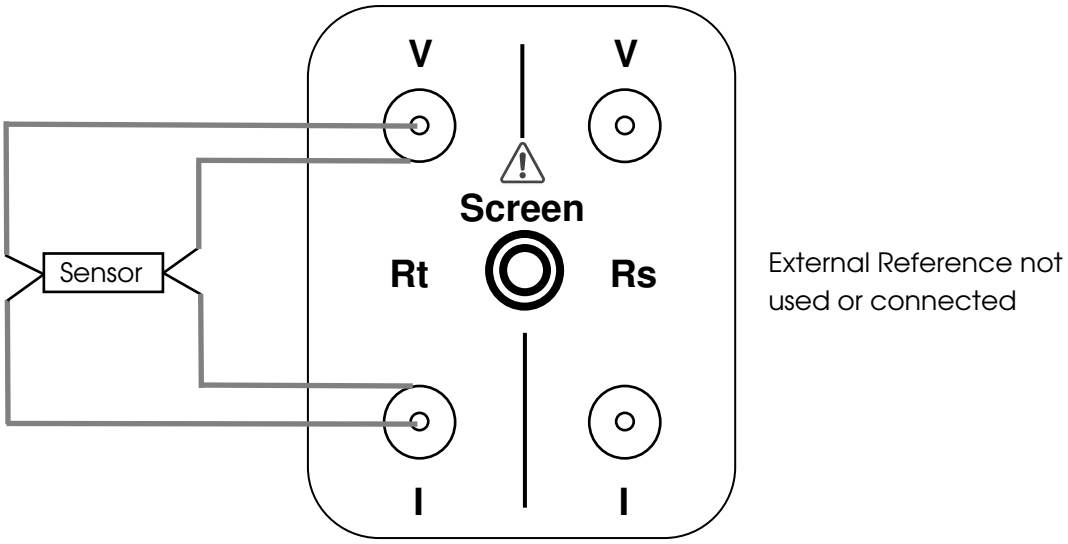



**Figure 4.1 - connections when using an internal reference resistor**

The screen connection may be used when noise is an issue. In this case, both connections to the BNC must be screened (together) and this outer-screen is connected to the **Screen** connection.

**Note**
The outer conductor of the BNC connectors is not at earth potential and should not be earthed.

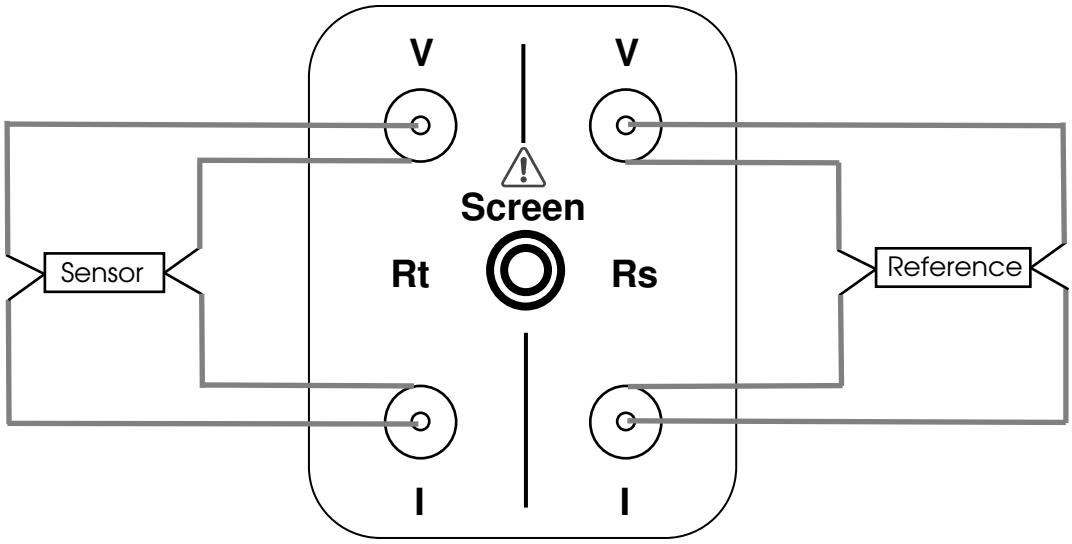



**Figure 4.2 - connections when using an external reference resistor**

### 4.1.1 Connection and guarding

Two coaxial BNCs are provided for connections to each resistor. The normal four terminal connection arrangement is shown in Figure 4.2. The lower coaxial connector of the $R_t$ and $R_S$ connector pairs is the current drive and should be connected to the resistors as shown. A single braided, outer conductor is driven from a low impedance source and effectively screens the returning current on the inner coaxial conductor.

The upper coaxial connectors in Figure 4.2 are the voltage sense lines and should be connected to the resistors as shown. The inner conductor is connected to the 'low' point and the outer to the 'high' point of the resistor, i.e. the screen connects to the voltage terminal on the same side of the four terminal resistor as the screen of the current drive cable. This point is the driven, 'high' point of the resistor. The inner conductor is connected to the 'low' point of the resistor and is at the same end as the inner conductor from the current drive cable. In this way, the outer cable screens are driven and provide screening for the low side of the resistor and cable inner conductors.

Additional guarding is provided by the guard circuit. This drives the "tail" of the bridge so that the common point of $R_S$ and $R_t$ is held at virtual ground potential. This common point is the low point of each resistor. Hence the high points are at opposite ends of the bridge and are each driven, but with opposite polarity. Although the low point of the resistors are held near earth potential by the guard amplifier, this is not a true earth and electrical connection other than the two bridge cables should be avoided. Where connections cannot be made

directly to the resistor assemblies it is recommended that the join between the resistor leads and the coaxial cables is made with the FA-3 adaptor box. Flying leads from the resistor assemblies should be twisted in two pairs, the current **I** leads together and the voltage **V** leads together.

### 4.1.2 Two terminal resistors

Two terminal resistors can be used with the Model F600 Bridge. Two terminal resistors must be converted to four terminal devices to take full advantage of the instrument's performance. The connector leads should be soldered on to each lead of the two terminal resistor[6], as shown in Figure 4.3. Standard coaxial cables should be used for connection to the F600 Bridge. In the case of a two terminal thermometer the FA-3 adaptor box should be used. The thermometer leads should be connected so as to link the two high terminals together and likewise for the two low terminals.

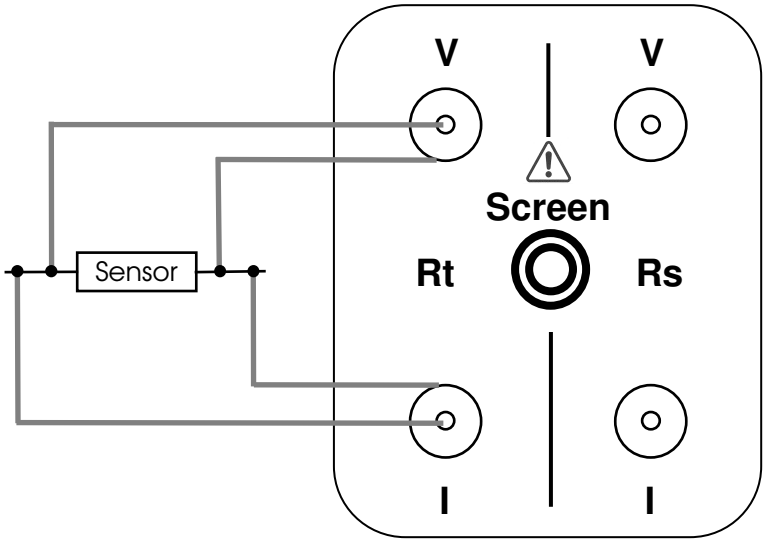



**Figure 4.3 - modification for a two terminal resistor**

### 4.1.3 Resistor current selection

The normal resistor current setting is 1mA; higher and lower settings can be used. To maintain the bridge within operating limits the IR voltage drop on the standard resistor should not exceed 200mV rms on the input . This limits the $R_S$ resistor to about 200 ohms when using the

[6] Note that the voltage sense connections should be soldered nearer to the resistor (or sensor) body than the current drive connections.

1mA current. High value sensors must be operated with a lower current setting. The $R_f$ resistor value is limited to 5 times the $R_S$ resistor value.

Conversely, low value resistors (below 10 ohms) may develop too small a voltage to give an adequate signal to noise ratio and a higher current settings may be required. Inevitably, for a given resistor, higher currents lead to higher self heating effects. The √2 current multiplier will cause a doubling of the power developed across each resistor and can be used with the other current settings to estimate the effect of self heating on the sensor or resistor being measured.

# 5. Operating the F600

## 5.1 Instrument operating modes

The instrument has two operating modes -

- **Measurement Mode** which displays the measurement and the instrument status
- **Menu Mode** which allows selection of operating conditions and its settings[7]

### 5.1.1 Measurement mode (normal)

In Measurement Mode, the screen displays the current reading (and its units - ratio, resistance or temperature), reference resistor (value and type) the current channel and probe selected and the instrument's gain; statistics and the time of day are also shown. This is the normal operating display for the F600. The display will look similar to the one shown below[8] –

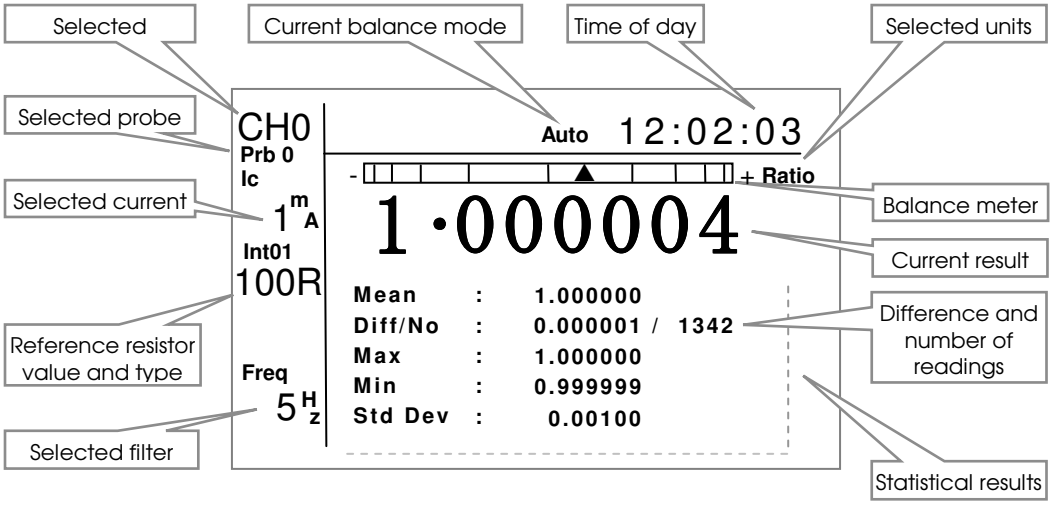



**Figure 4.1 – F600 display screen**

The currently selected channel and probe (here 0 is the default for both) are always shown at the top left of the display.

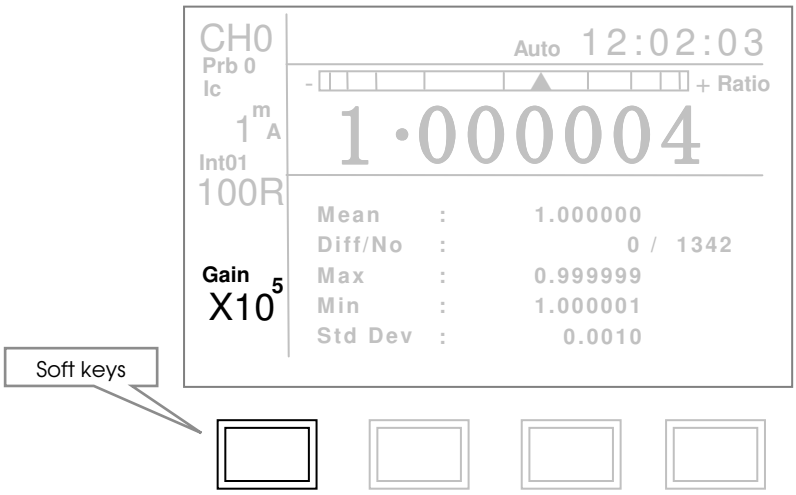
[7] However, measurements are still displayed in menu mode whenever possible.

[8] The display may be toggled between this view and a graphical display using the **Disp** key.

This display always reflects the operation of the instrument, showing the current reading and settings. Readings are updated at the selected filter rate[9].

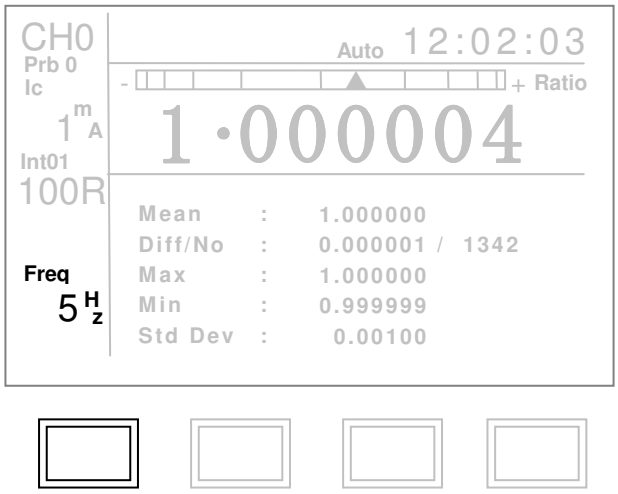
### 5.1.2 Measurement mode (alternative display)

There are four **soft-keys** are under the display. The action of these keys is context sensitive – their action generally depends on the text above them on the screen. Two of these keys (left-hand side) are active when the display is in normal measurement mode.



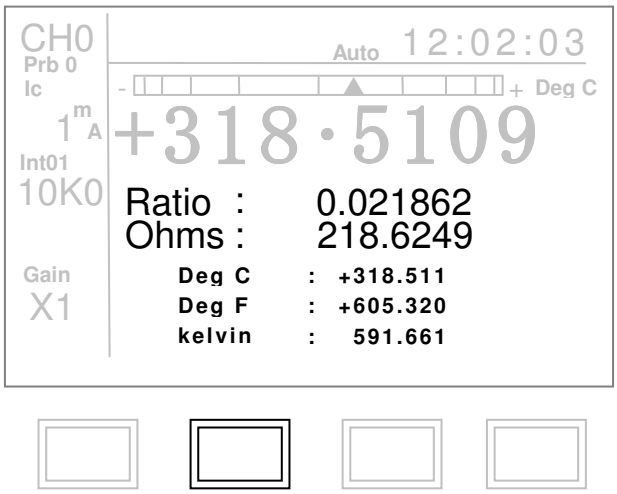

i

The far left soft-key toggles the screen between Gain and Filter display (see above and below).




[9] Depends on the filter value selected.

The other active soft-key (second to left in normal measurement mode) toggles between normal measurement mode and the screen showing multiple-unit conversions (see below).




### 5.1.3 Measurement mode (graphical - Disp function key)

Press the **Disp** key to change the display from normal measurement mode to graphical display mode (shown below).

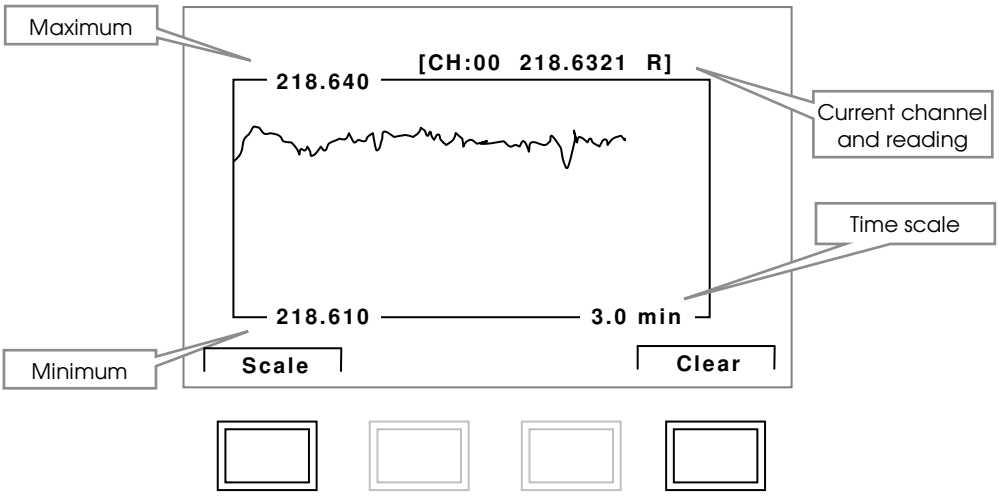



**Figure 4.2 – F600 graphical display mode**

The screen shows a record of measurements[10]. The display automatically scrolls to the left once the initial x-axis period has been displayed (starting from the left-hand y-axis – i.e. the

[10] The x-axis scale depends on the filter setting (time between samples – 6 minutes for a 2 second update rate).

most recent value is displayed on the right-hand side), The F600 automatically rescales the y-axis when when the graph is first displayed; pressing the Scale key will refit the graph to the screen. As points are added, the horizontal axis of the graph increases to display the new points. At some time, the early points will be removed from the start, possibly leaving the horizontal scale too large for the points being displayed. Instead of re-starting the graph (and losing valuable history) hit the scale key and the horizontal scale will re-adjust to fit all the displayed points..

Pressing the **Disp** key will change from this mode to **Standby** mode. Pressing it again will change the display back to (normal) Measurement mode.

### 5.1.4 Measurement mode (standby - Disp function key)

Press the **Disp** key to change the display from graphical display mode to **Standby** mode (see section 3.3.2). This mode saves power as the VFD display is blank.

Press the **Disp** key once more to return to normal measurement mode.

## 5.2 Setting the instrument's operating conditions

The most commonly used keys are grouped together at the top of the front panel into nine **Specific Function** keys. These keys are used to select the instrument's operating mode. Function key operations are generally independent of each other[11]. As an example, press the **Units** key and the display will change to the following one –

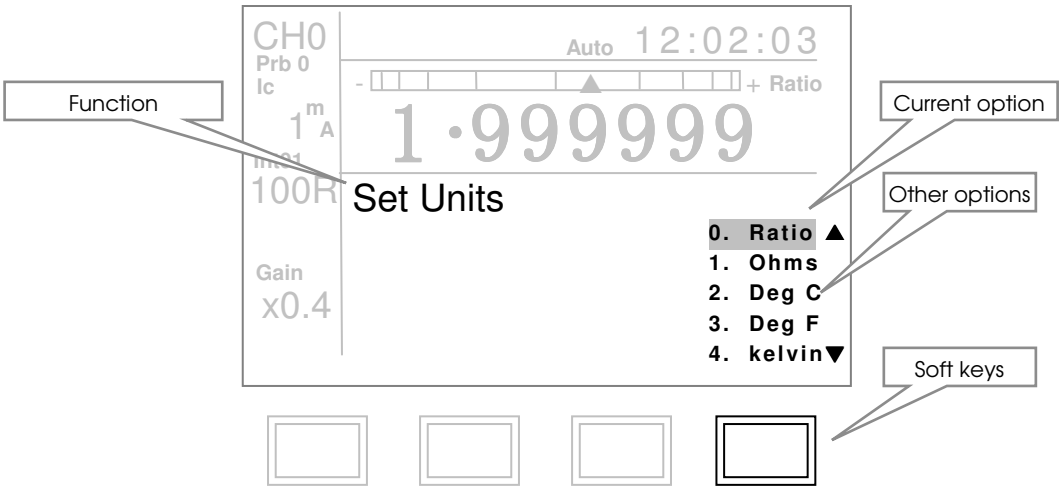



**Figure 5.2 – unit selection example**

There are four parts to the screen. The **function description** shows the currently selected menu – in this case **Set Units**. The currently set (selected) value is shown in reverse video (i.e. the current units); the **other options** are displayed below.

> **Note**
>
> The instrument continues to measure in menu mode. Selecting one of the available options will change the instrument settings immediately (with the exception of the current menu).

Four **Soft-keys** are situated below the VFD. There are three ways to change the current set value –

[11] Except in the case of the gain and current menus which are limited by instrumental considerations.

- **Method 1**

  Use the ▲ and ▼ navigation keys to scroll the selection (inverse video line) through the available options

- **Method 2**

  Use the soft key under the menu to scroll the selection (inverse video line) through the available options

- **Method 3**

  Use the numerical keypad to set one of the available options – for example, pressing the number 4 will set the units immediately to **kelvin**

Press the **Units** key or the **OK** key (in the navigation cluster) or the **Back** to return to normal operation.

The **Specific function** keys are described in detail in the following sections. The default values are shown in each section.

Note that it is not necessary to press the current function key or OK key to move to another menu; simply pressing a function key will immediately move there.

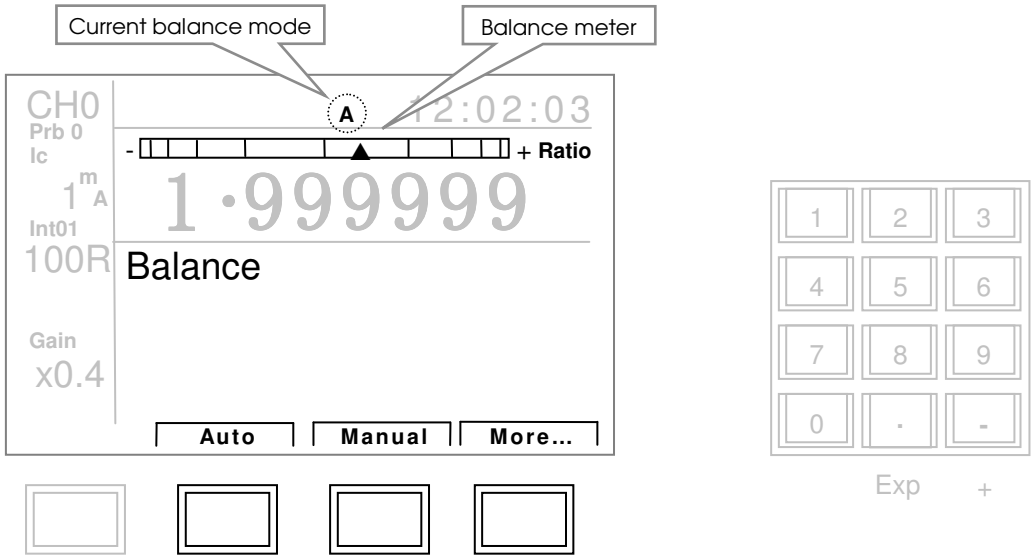
### 5.2.1 Automatic/Manual balance function shift key

Press the **Shift** function key followed by the **Auto/Man** shift-key to toggle the balance mode between **Automatic** and **Manual**; the change to the balance method is implemented immediately.

The bridge may be balanced manually (ratio only) or set to balance automatically. The current balance mode is indicated by the letters '**M**' (Manual) or '**A**' (Automatic) on the top line.

A logarithmic balance-meter is displayed on the screen. The bridge is balanced when the indicator arrow is positioned exactly over the centre of the meter. When balanced, the indicator will change to a solid diamond shape.

The bridge input circuit includes two functional checks - zero and unity indicated by the symbols **'=0='** and **'=1='** on the top line.




The special operating modes are useful to check that instrument is working correctly and to check that the bridge can be balanced with the active settings.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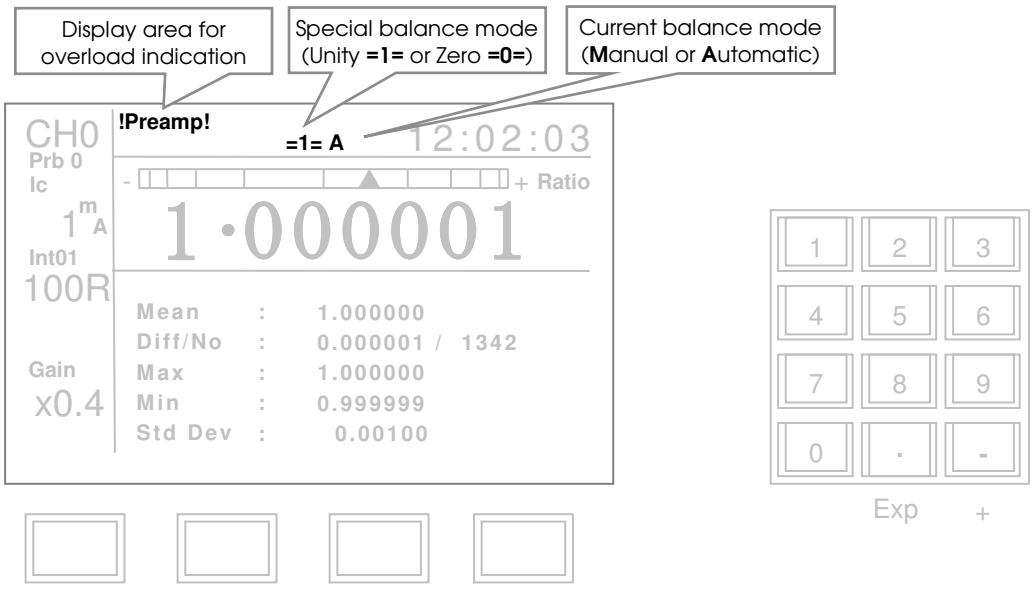



The bridge will start operating in the selected mode immediately one of the balance mode soft-keys is pressed. Operating modes are described below.

#### 5.2.1.1 Automatic balance (normal mode)

This is the **Normal** operating mode. The bridge will attempt to balance automatically using the settings for the currently selected channel[12]. There may be valid reasons why the bridge cannot balance, and these will be indicated to the left of the balance mode symbol. The display will show the decades change as balance is approached. The update rate, on all but the last attempt, is the minimum length of time needed to settle after a change; at the end of this process, the settling time will be determined by the currently set filter.

The usual reasons the bridge cannot balance are due to overload conditions; reduce the current and/or gain to reduce the overload condition. Alternatively, the $R_t/R_s$ ratio may exceed the 4.99999:1 limit of the bridge; in this case increase the reference resistor value.

Note that the bridge may display error conditions during the initial balance phase. This is normal while the system changes gains to reach a balance. The error conditions will disappear as the bridge approaches the balance position.

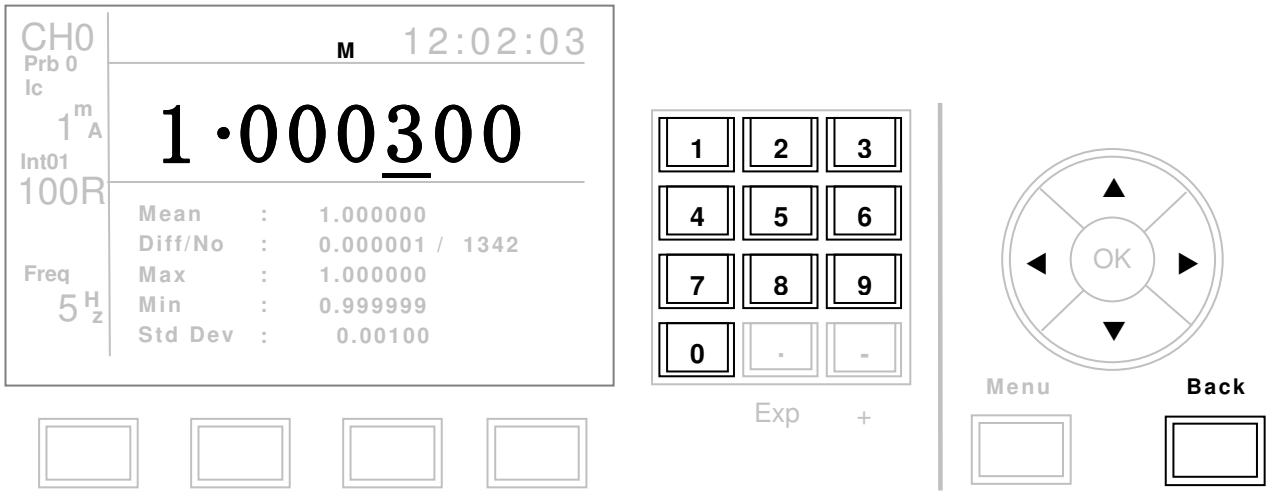
#### 5.2.1.2 Automatic balance meter

The meter indicator will change to a diamond symbol when the meter is balanced. The meter scale is logarithmic.

[12] The bridge's gain is automatically increased by the bridge as the balance point is approached.

#### 5.2.1.3 Manual balance

The bridge may be balanced manually when the in ratio mode. This is not normally necessary; it is usually impossible to better automatic balance unless the input signal is very noisy.




Select **Manual** mode using the soft-key. Once manual mode is selected, a cursor will appear under the currently active digit (**3** in the example above). Use the ▲ (up) and ▼ (down) keys to change the value of the active digit and use the ◀ (left) and ▶ (right) keys to select the adjacent digit. Alternatively, the digits may be entered from the numeric keypad. Use the **Back** key to reset the whole balance value to 0 and to select the left-hand digit.

The logarithmic meter gives an indication of the error (distance from balance) at the active gain. It will be necessary to increase (or initially decrease) the gain to reach a balance[13].

In the example above, the meter indicates that the balance value is slightly too low[14] (the meter-pointer is to the right of centre) and, consequently, the ratio needs increasing. Manual balanced is achieved by gradually changing the displayed ratio to converge on the best result (minimum error on the meter at highest practical gain).

**Manual balance procedure (bridge in ratio mode)**

1 Select **Automatic** mode (via the shift key and **Auto/Man**) and let the bridge balance automatically - this will quickly get you near or at a balance point.

[13] The balance update rate is approximately 1/3rd of the currently set filter.

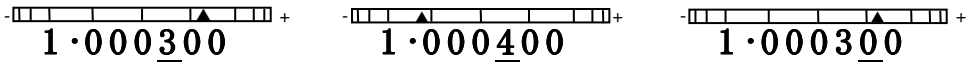
[14] The bridge is close to balance (at the currently active gain) since the pointer is not at one end of the meter.

2 Select **Manual** mode (via the shift key and **Auto/Man**) and observe the meter-pointer. Decrease the selected digit if the pointer is to the left of centre (or increase the value it the pointer is to the right).

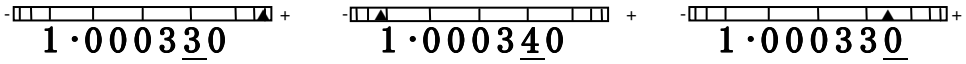
3 Move the pointer as close as possible to the centre of the meter with the selected digit. Increase the gain as the balance point is approached[15].

4 Once the current ratio cannot be improved, press the ▶ (right) key to select the digit one decade to the right (10 times more sensitive) and repeat the process until a change in the least significant digit does not improve the balance result.

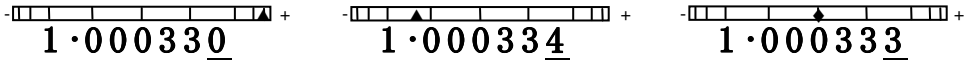
An example is shown below for of a manual balance sequence (starting from somewhere near balance). The balance sequence is shown taking place from right to left –



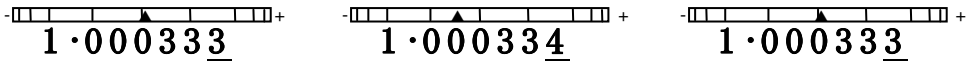

Increase the gain by a factor of ten to increase the meter sensitivity.




Increase the gain by a factor of ten to increase the meter sensitivity.




Increase the gain by a factor of ten to increase the meter sensitivity.




The bridge has been optimally balanced since no improvement can be made in the least significant digit.

An alternative strategy can be adopted If you know the $R_t$ value approximately; calculate the ratio $R_t/R_s$ and use this as a starting point from which to balance the bridge.

[15] Initially select the minimum gain If balancing from an unknown starting-point.

#### 5.2.1.4 Zero balance mode

The F600AC bridge has an internal zero check facility. This mode is useful to confirm that the bridge is operating correctly.

In this mode, the common point of the inductive divider is disconnected from $R_t$ and connected to $R_t/R_s$ common point. Setting the divider ratio to zero in all decades should give a balanced result of 0.000000. Any errors due to standing currents, pick-up or offsets will be compared with the other zero-input and will give a non-zero value.

There is no need to fit the $R_S$ resistor if the internal reference is used - however a resistor must be fitted to the $R_t$ terminals and the bridge parameters must be set so that a valid balance can be obtained with the $R_t$ value connected.

Remember to select automatic balance unless you wish to manually balance the bridge.

The bridge should display zero to within ±2 ppm in ratio mode.

Press the **Shift** key and then the **=0=** shift key to start zero balance mode (use the same key sequence to exit zero balance mode).

#### 5.2.1.5 Unity balance mode

The F600AC Bridge has an internal unity check facility. This mode is useful to confirm that the bridge is operating correctly.

Selecting the unity check causes the common point of the inductive divider secondary to be connected to the $R_t$ side of $R_S$. This should give a balanced result of 1.000000.

There is no need to fit the $R_S$ resistor if the internal reference is used - however a resistor must be fitted to the $R_t$ terminals and the bridge parameters must be set so that a valid balance can be obtained with the $R_t$ value connected.

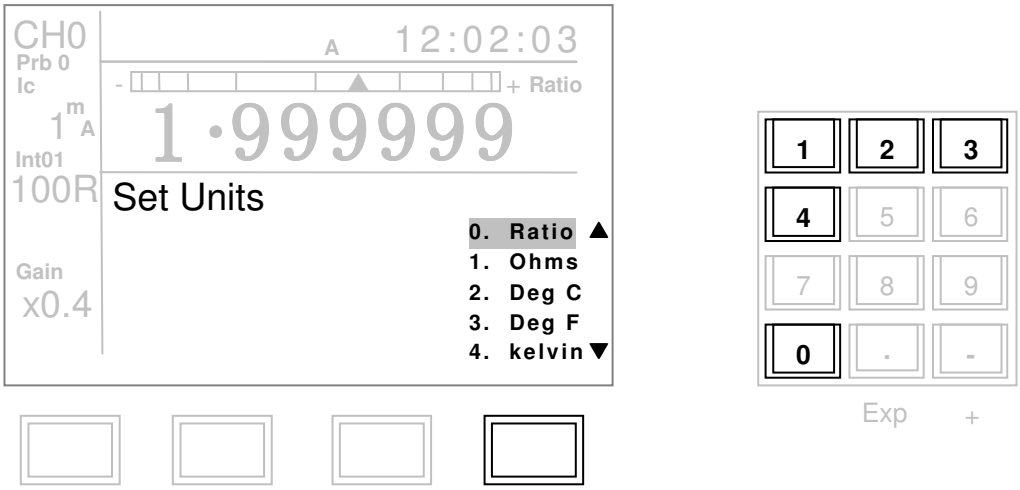
Remember to select automatic balance unless you wish to manually balance the bridge.

The bridge should display unity to within ±2 ppm in ratio mode.

Press the **Shift** key and then the **=1=** shift key to start unity balance mode (use the same key sequence to exit unity balance mode).

### 5.2.2 Units function key

Press the **Units** function key to show the units menu. Select the units you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Units** key or the **Back** key to return to normal measurement mode.




The effects of the Units selection menu are shown in the table below —

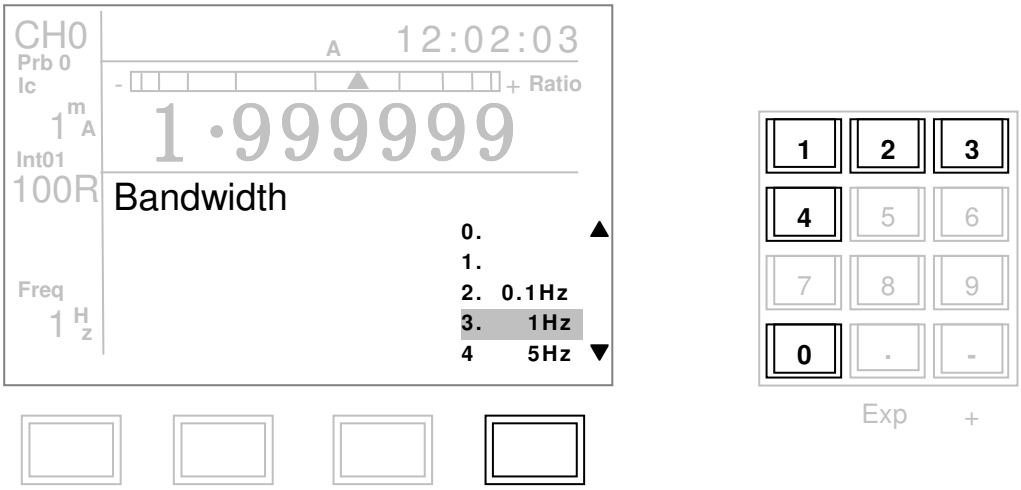
| Units | | |
|---|---|---|
| **Unit** | **Description** | **Function** |
| **0** | Ratio | Normal operation. Show measured ratio |
| **1** | Ohms | Convert ratio to ohms and display |
| **2** | Deg C | Convert ratio to celcius and display |
| **3** | Deg F | Convert ratio to farenheit and display |
| **4** | kelvin | Convert ratio to kelvin and display |

### 5.2.3 Filter function key

Press the **Filter** function key to show the filter (bandwidth) menu. Select the bandwidth you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Filter** key or the **Back** key to return to normal measurement mode.

Five bandwidth filters are available, as shown below. Select the one that best matches and is consistent with the physical time-constant of the process you are measuring.

The smaller the bandwidth value, the better the noise reduction; however, noise reduction is achieved at the expense of response to fast-changing processes.




The effects of the **Filter** selection menu are shown in the table below –

| Filtering | | |
|---|---|---|
| **Filter** | **Description** | **Function** |
| **0** | 0.1 Hz | 10 second bandwidth |
| **1** | 0.5 Hz | 2 second bandwidth |
| **2** | 1 Hz | Default , 1 second bandwidth |
| **3** | 2 Hz | 0.5 second bandwidth |
| **4** | 5 Hz | 0.2 second bandwidth |

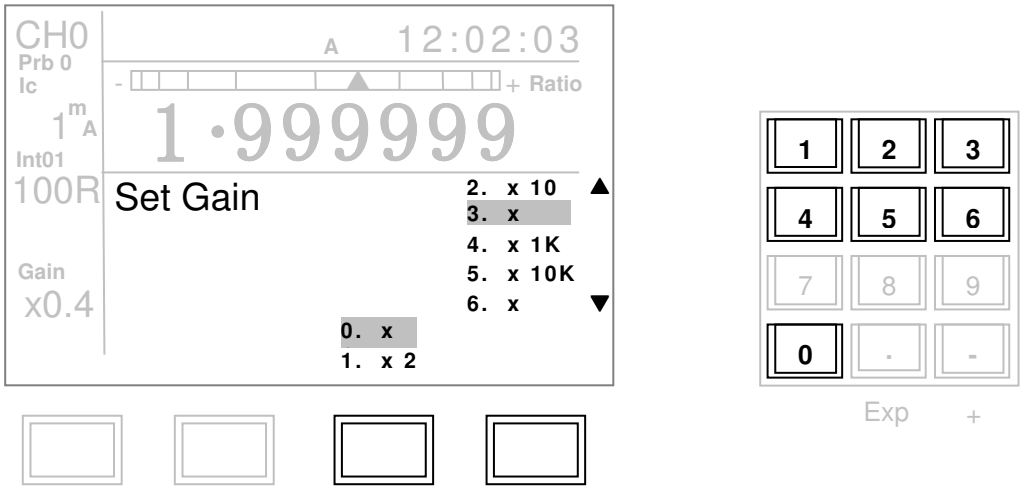
### 5.2.4 Gain function key

Press the **Gain** function key to show the gain menu. This is only useful in **Manual** balance mode[16]. Select the gain settings you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Gain** key or the **Back** key to return to normal measurement mode; both right-hand soft-keys are used for this menu. Use the ◀ / ▶ keys to move the navigation-key selection between the two columns.

Two gain tables are available and may be used in any combination. So, in the example shown below, a total gain of 100 is selected (1 x 100). Pressing 1 and 5 would give a total system gain of 20,000 (2 x 10K).

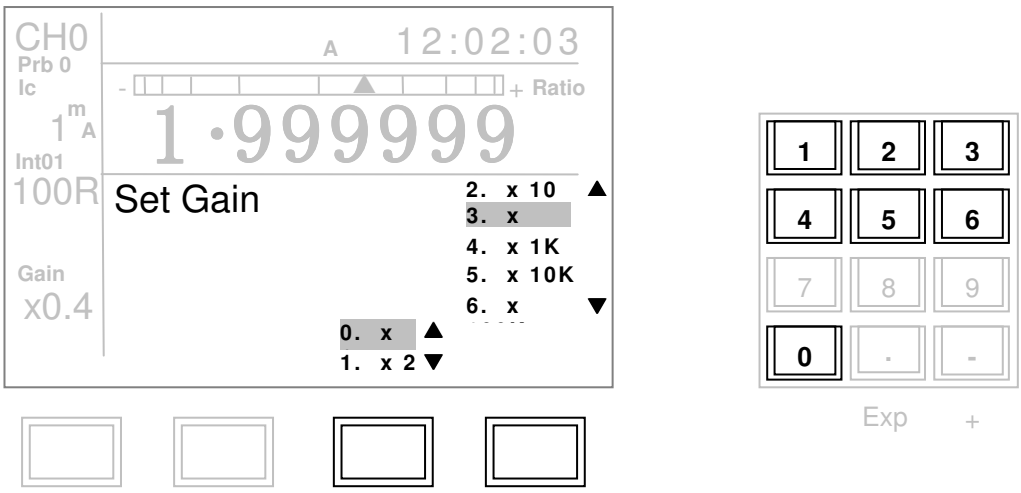
Use as high a gain as possible to manually balance the bridge, remembering that if the gain is set too high, the system may not be able to cope with the full dynamic range and noise. The gain used will also depend on the probe-current setting.

Note that the instrument's balance point will not be optimised if the gain is set too low.




Press the ◀ key to move the column selection to the left (see next page). The ▶ key will move it back to the right-hand column.

[16] The gain will be adjusted by the instrument when Automatic balance mode is selected.




The Bridge's gain may be set to –

10, 20, 100, 200, 1000, 2000, 10000, 20000, 100000, 200000, 1000000, 2000000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### 5.2.5 Curr(ent) function key

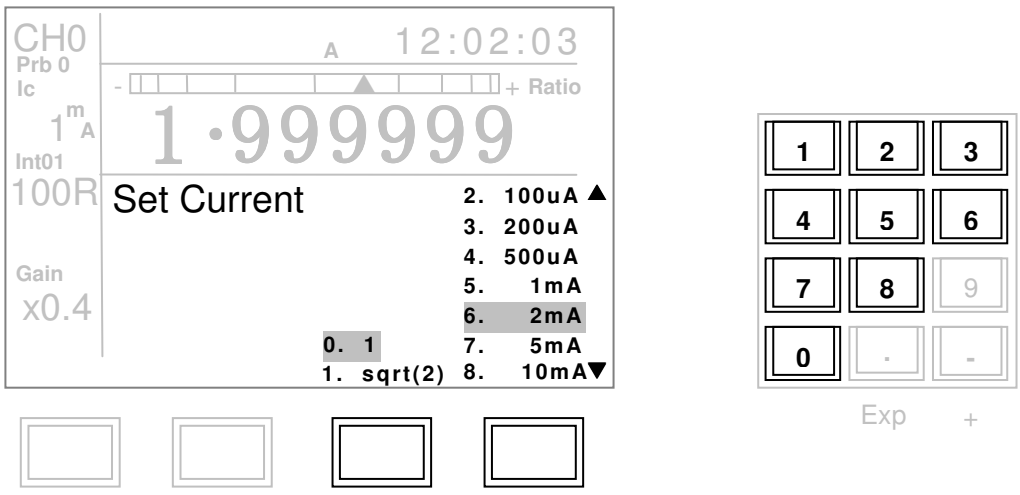
Press the **Curr** function key to show the current selection menu. Select the current setting you require using the soft-key, the ▲ / ▼ navigation keys or the numerical keypad; the change to the current value is implemented immediately. Press the **OK** key, the **Cur** key or the **Back** key to return to normal measurement mode. Use the ◄ / ► keys to move the navigation-key selection between the two columns.

> **Note**
>
> The current menu is slightly different to other menus since changing the setting on this screen does not immediately change its value. This is because, for example, scrolling down from 1mA through 10mA and back to 10µA may unacceptably increase self-heating.

Two current tables are available and may be used in any combination. So, in the case shown below, a total current of 2mA is selected (1 x 2mA). Pressing 1 and 7 would give a new setting of 5mA (1 x 5mA).

Use as high a current as possible for your measurement, remembering that if the current is set too high, self-heating effects in the probe (or resistor) may become significant.

Note that the instrument's performance will not be optimised if the current is set too low.




The F600's currents may be set to –

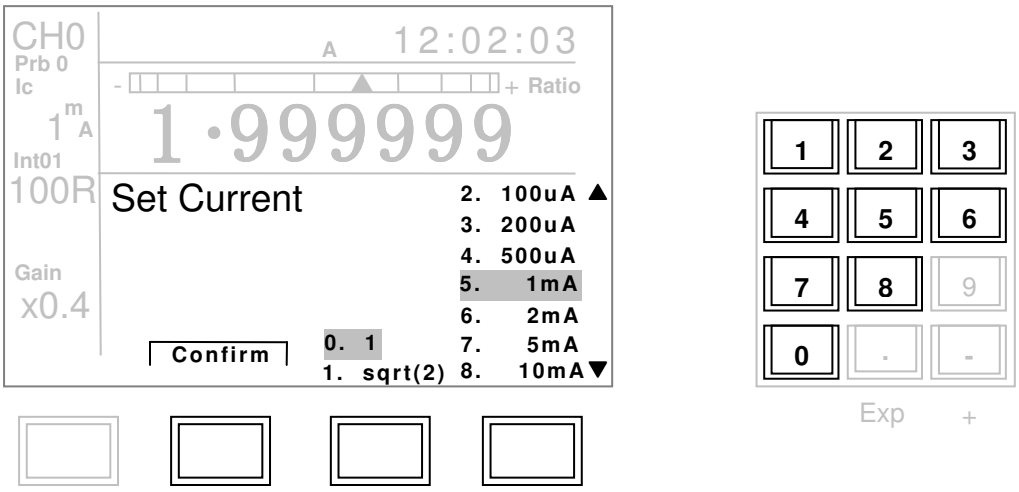
100 µA, 200 µA, 500 µA, 1 mA, 2 mA, 5mA, 10 mA

(√2x100 µA), (√2x200 µA), (√2x500 µA), (√2x1 mA), (√2x2 mA), (√2x5mA), (√2x10 mA)

The (x√2) setting doubles the power in the probe (or resistor) and is useful when checking for self-heating effects.

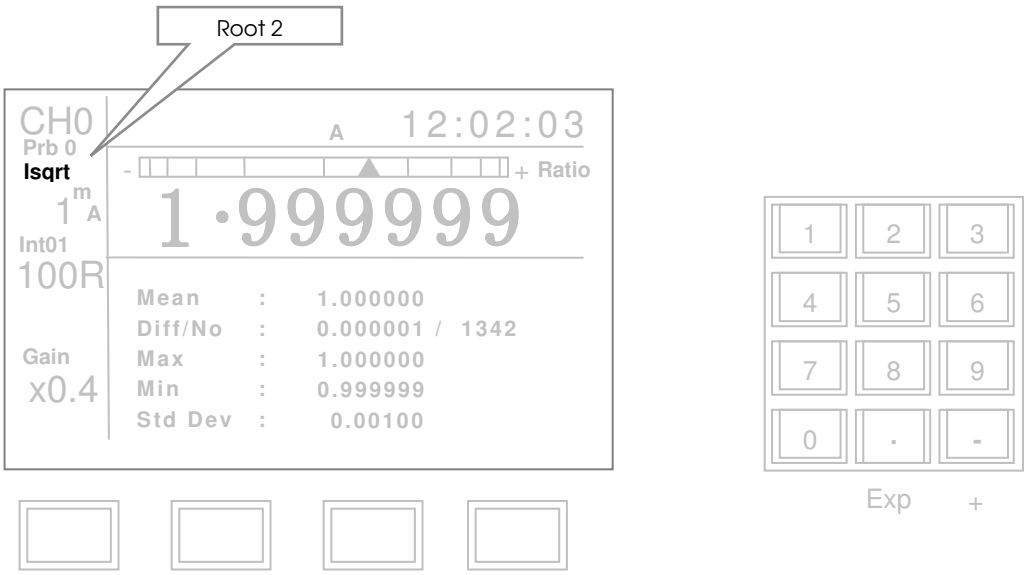
Pressing the 1 and 5 keys on the numeric keypad will show the display below.

Note that the **Confirm** legend has appeared above the 3rd soft-key; this is used to prevent any menu changes from taking effect immediately. Either press the **Confirm** soft-key (and note that the display will return to the one shown above) or press the **OK** key (and the display will return to the measurement mode). Pressing the **Curr** key or **Back** key will return control to the top level measurement menu without altering the current value.



### 5.2.6 Root 2 (√2) function key

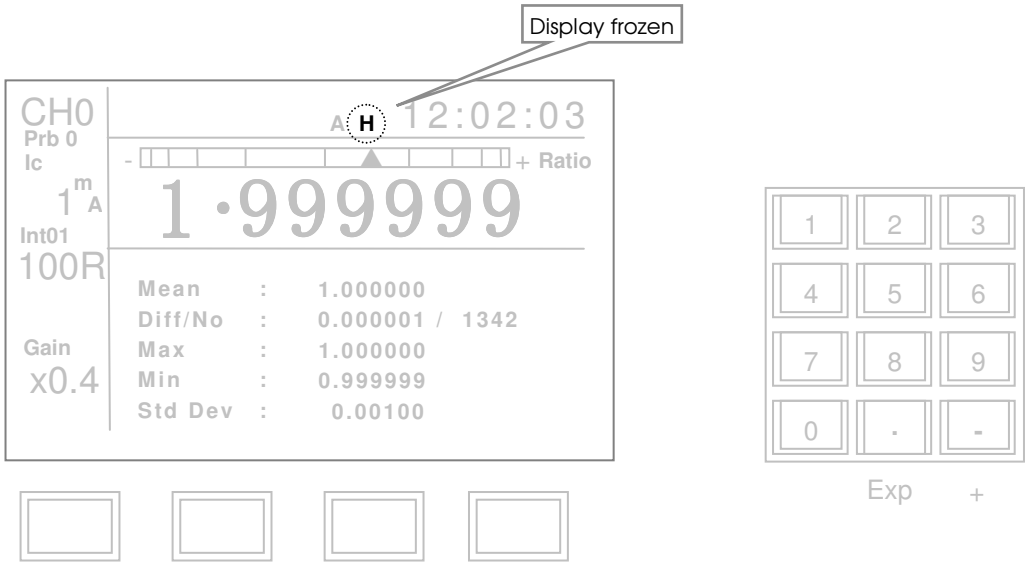
The **Root 2 (√2)** function key does not have a menu associated with it. Press the **Shift** function key followed by the **√2** shift-key to toggle the current between x1 and x√2; this is indicated by the letter **Isqrt** and **Ic** legends on the display (see below).




This is a shortcut to the function available on the **Curr** menu, but, unlike the **Curr** menu, it's effect is immediate (without the need to confirm the change).

### 5.2.7 Hold function key

The **Hold** function key does not have a menu associated with it. Press the **Hold** key to freeze the value shown on the display; this is indicated by the letter **H** on the top line (see below). Measurements continue even if the display is frozen.

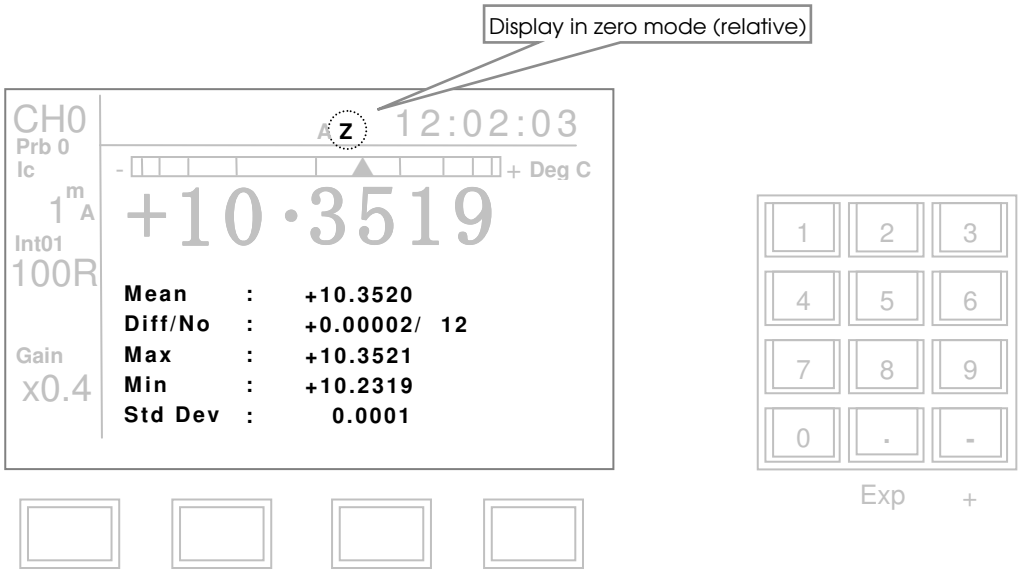



Press the **Hold** key to un-freeze the display.

### 5.2.8 Zero function key

The **Zero** function is useful when looking for changes. The current reading is held and then subtracted from subsequent readings.

The function key does not have a menu associated with it. Press the **Zero** key to zero the value shown on the display. This is indicated by the letter **Z** on the top line (see below).




The zero function can be used with any of the instrument's temperature units; it will not work when ratio or resistance is selected.

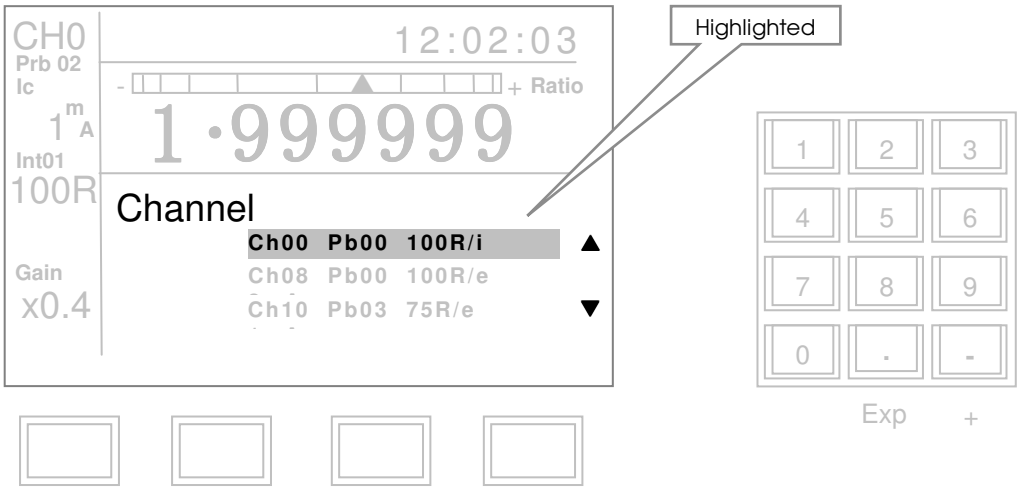
| **Note** |
| --- |
| A warning message will appear if the zero function key is pressed when temperature mode is not selected. |

Zero mode can be turned off by pressing the **Zero** key again.

| **Note** |
| --- |
| Zero mode will remain active until it is turned off or the mode is changed |

### 5.2.9 Chan function key

Press the **Chan** function key to show the channel selection menu.




A list of active channels will be shown. Use the ▲ / ▼ navigation keys to scroll the highlighted line up or down the list (up to three lines are displayed on the screen due to space limitations). Press the **OK** key to select the highlighted channel or press the **Chan** key to select the highlighted line and return to measurement. Alternatively, press the **Back** key to return without altering the channel.

**Note**

Note that the **OK** key immediately selects the highlighted line (but does not return to normal measurement display), allowing you to individually view and select other channels.

For reference, the probe attached to this channel, the reference resistor and the current are also shown (these may be changed via the **Rs**, **Probe** and **Cur** function keys respectively).

#### 5.2.9.1 Channel selection

Up to 99 channels can be stored and edited; channel 0 is the default instrument channel.

| **Note** |
| --- |
| External channel numbering is only important when the F600 is used with a switch-box - otherwise, external channel numbering can be set as required. |

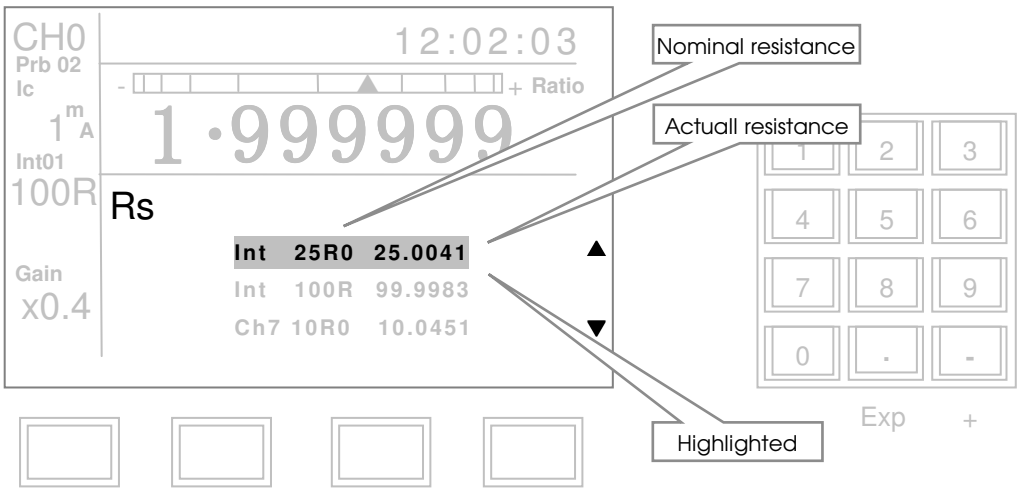
Each channel contains a set of instrumental conditions; channels can be used to quickly and efficiently restore a previous saved setup. Alternatively, they can be set to use the instrument efficiently with an external switch-box. External channels may be set to perform either as $R_t$ or $R_s$ inputs.

### 5.2.10 Reference resistor function shift key

One of two internal reference resistors or up to one of 99 external reference resistors may be selected.

Press the **Shift** function key followed by the **Rs** shift-key to show the reference resistor menu.

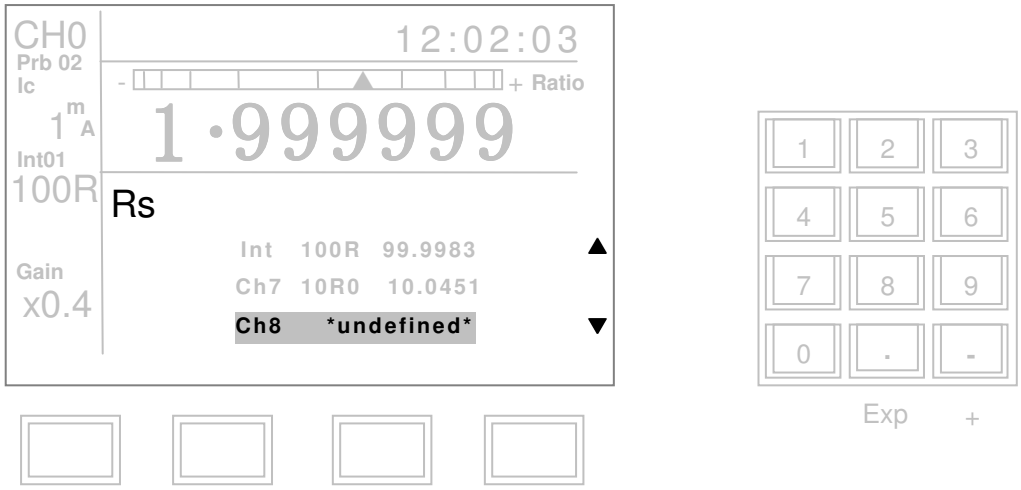
> **Note**
>
> External reference resistors are entered as $R_S$ channels.




A list of available reference resistors will be shown. Use the ▲ / ▼ navigation keys to scroll the highlighted line up or down the list. Press the **OK** key to select the highlighted reference resistor or press the **Rs** key to select the resistor and return to measurement mode; alternatively, press the **Back** key to return without altering the reference resistor.

> **Note**
>
> Note that the **OK** key immediately selects the highlighted line (but does not return to normal measurement mode), allowing you to individually view the effects of the change and to select other resistors.

As an example, once the highlighted line has been scrolled down three times, the display will change to one similar to the screen below –




This screen shows that two external reference resistors have be added to the instrument (channels 7 and 8) but that channel 8 has not had an actual value entered for the reference resistor yet.

The two internal reference resistors[17] are set; their values are –

| Nominal values |
|---|
| 25 Ω |
| 100 Ω |

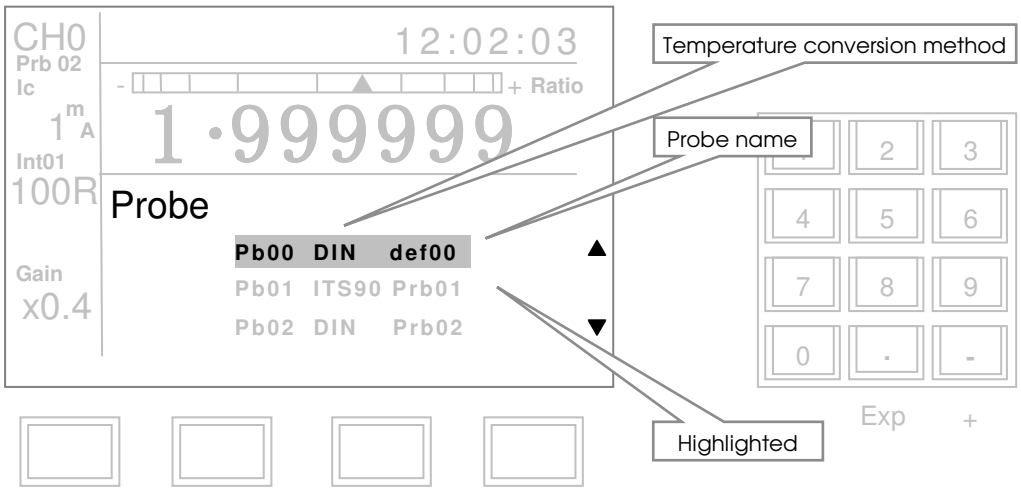
[17] It is important to realise that the number in the field is only a reference value; the actual value is entered via the calibration menu.

### 5.2.11 Probe selection function shift key

Up to 99 probe selections may be made (provided these have been entered).

> **Note**
>
> Probe 0 (def 00) is predefined as DIN and cannot be changed.

Press the **Shift** function key followed by the **Probe** shift-key to show the probe menu –

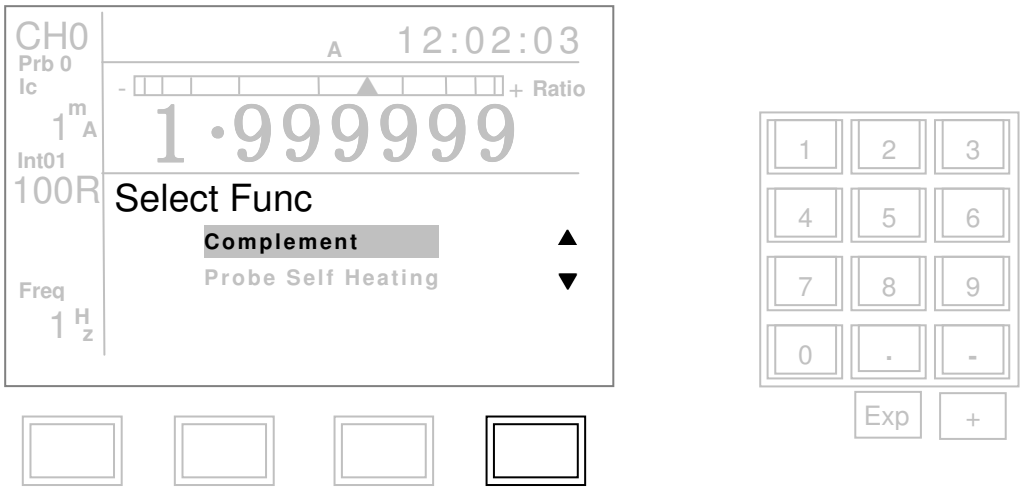



A list of available probes will be shown. Use the ▲ / ▼ navigation keys to scroll the highlighted line up or down the list. Press the **OK** key to select the highlighted probe or press the **Chan** key to select the highlighted probe and return to measurement mode; alternatively, press the **Back** key to return without altering the probe.

> **Note**
>
> Note that the **OK** key immediately selects the highlighted line (but does not return to normal measurement mode), allowing you to view other probes details.

### 5.2.12 Func function shift key

Press the **Shift** function key followed by the **Func** shift-key to show the function menu –




Two functions are currently available –

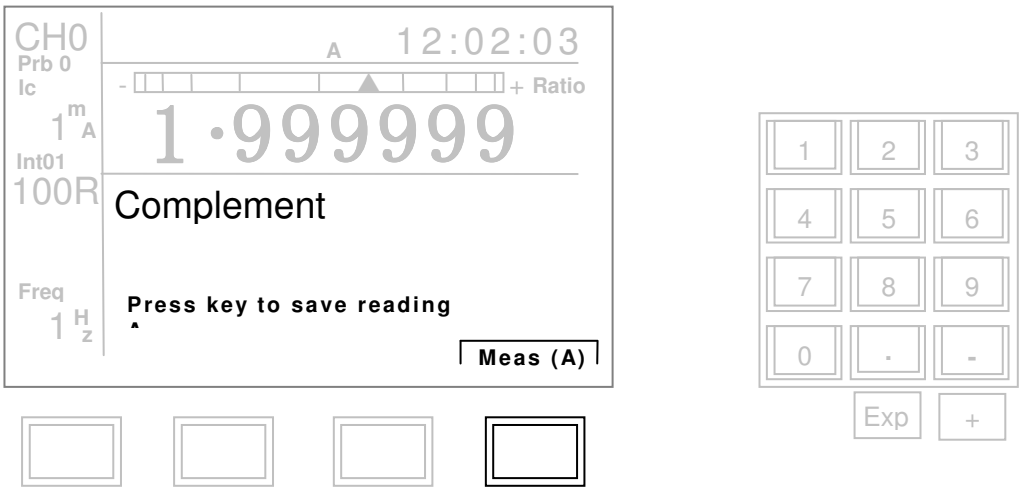
1 A bridge complement check, and

2 A probe self-heating check

Use the ▲ / ▼ navigation keys to select the required function.

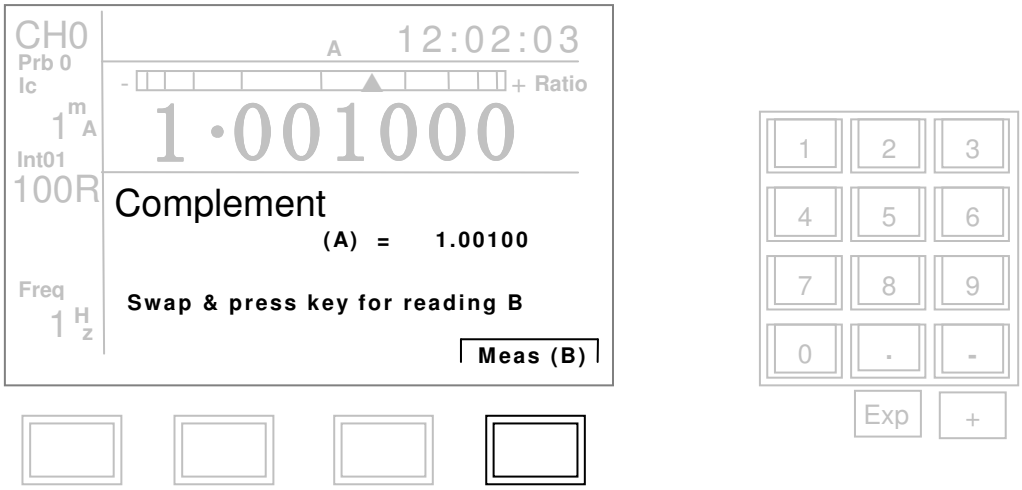
#### 5.2.12.1 Complement check

This test is useful to confirm that the bridge is operating correctly. Press the **OK** key to select this function. The following screen will appear –

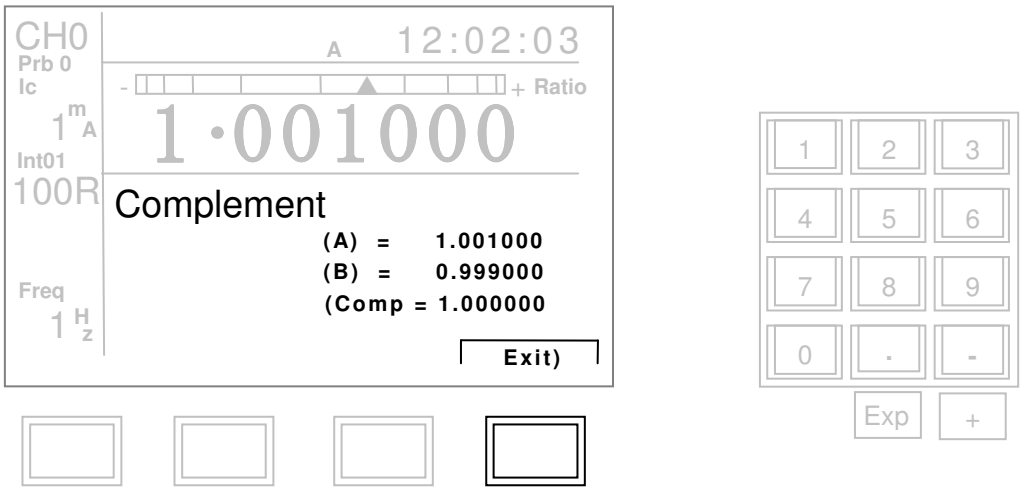


Choose two similar, stable resistors and attach these to the $R_t$ and $R_s$ inputs. Follow the on-screen instructions.

Press the **Meas (A)** soft-key to take the first reading. The screen will change to –




Swap the resistors and press the **Meas (B)** soft-key to take the second reading. The screen will change to –



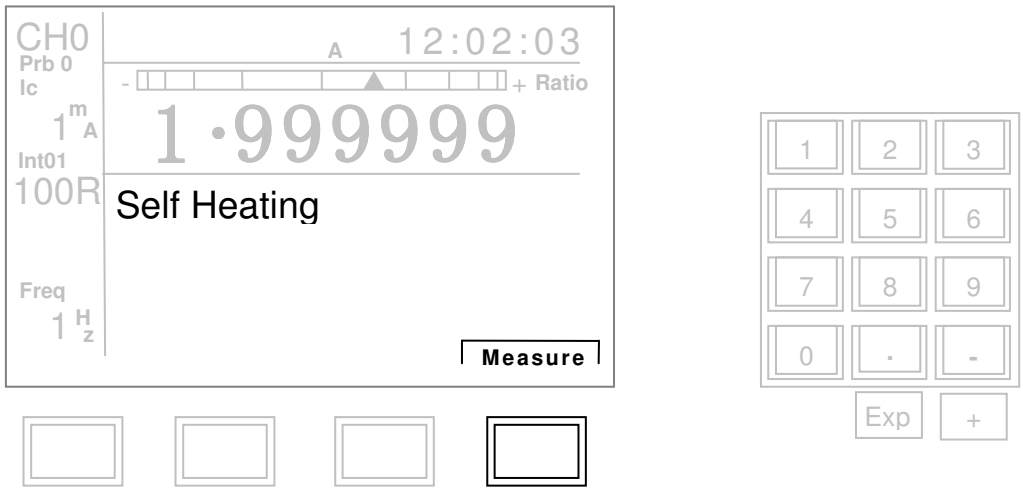

The two ratios should complement each other – i.e. multiplying the two together should result in a value of 1.000000 ±2 ppm (in the example, the two ratios are 0.999000 and 1.001000; multiplying these gives 0. 999000 x 1.001000 = 1.000000). The F600 does the multiplication automatically.

**Note**

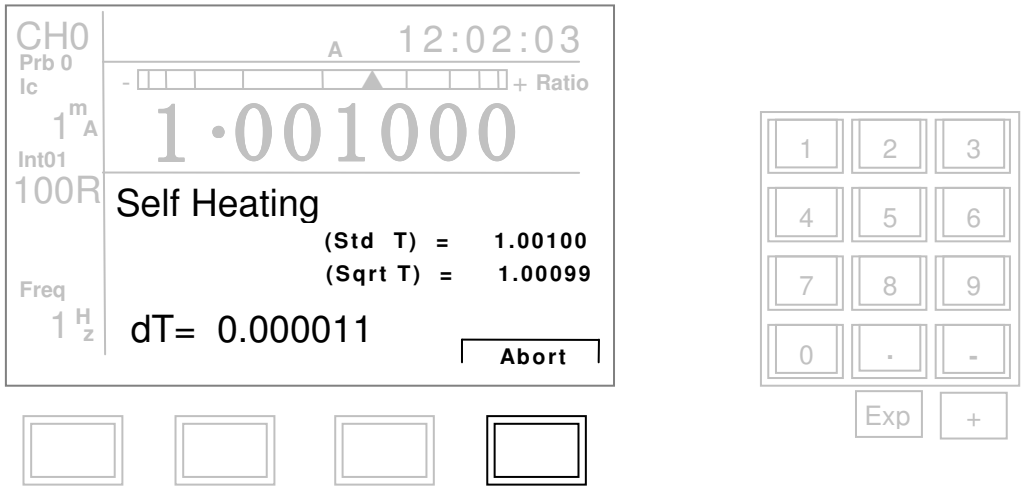
To perform a complement check, accurate to ±2 ppm, the two resistors must be stable over the measurement period.

#### 5.2.12.2 Self-heating check

This test is useful to check probe self-heating. Scroll to the **Probe Self Heating** function and press the **OK** key. The following screen will appear –




Press the **Measure** soft-key to start the process. The probe will be measured with the set current to start and then with √2 current after 40 seconds, when the following screen will appear –



### 5.2.13 Disp function key

The **Disp** function key does not have a menu associated with it.

The key is used to change VFD display modes. Three display modes available –

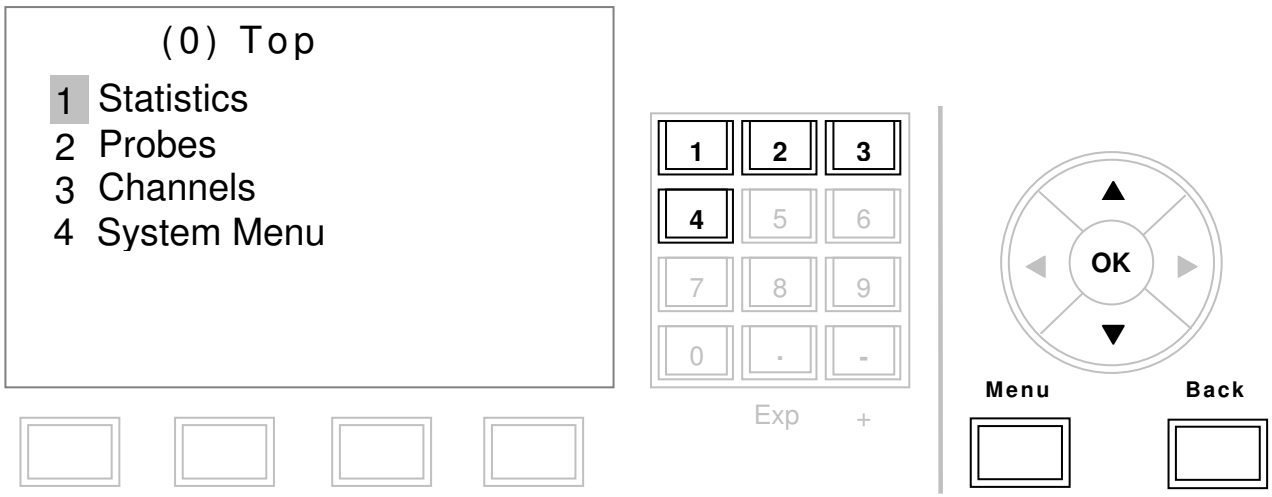
- Normal (measurement mode) display
- Graphical display
- Standby (VFD blanked)

Press the **Disp** key once to move between each of these modes (see section 5.1).

| **Note** |
| --- |
| The VFD display will be blanked (turned off) in Standby mode. |
| The orange Standby LED will be on when the Bridge is in this mode. |

## 5.3 Menu key

The **Menu** key is used to access all other aspects of the F600. These menus are used less frequently. Press the **Menu** key to display the top level menu. The ▲ and ▼ keys can be used to navigate through these menus. The numeric keypad is also active. The **Menu** key can be used to return to measurement mode. The **Back** key will cause the instrument to return to the previous menu (measurement mode if the top level menu is already shown).




The following sections describe each of these menus - and their sub-menus where appropriate. The statistics menu is shown below as an example of sub-menu.

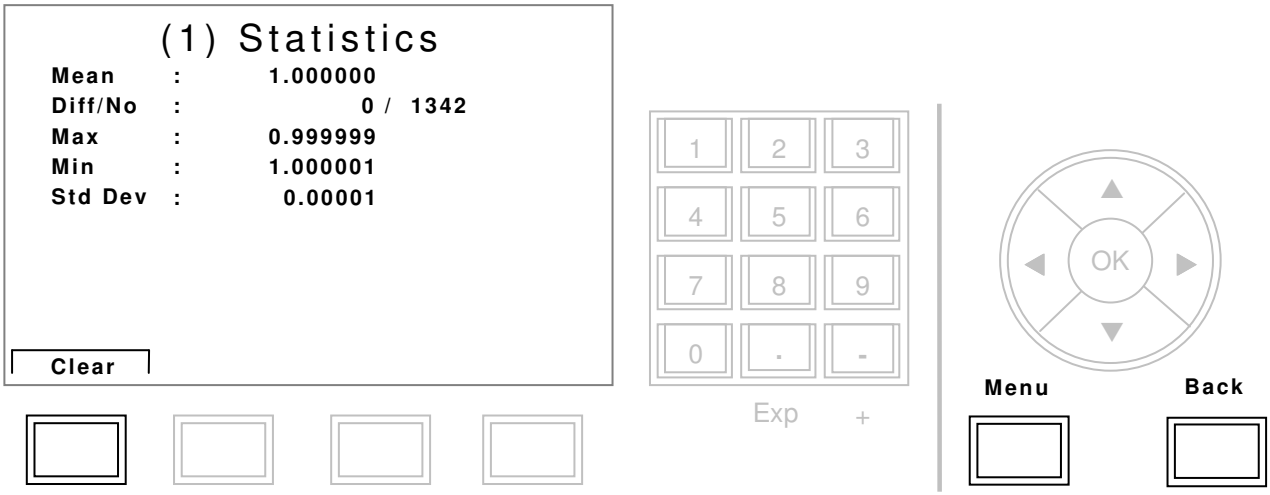
| **Note** |
| --- |
| The navigation cluster **Back** key will return to the previous menu. |

### 5.3.1 Password

Some menus are password protected (menus 22, 32, 44, 45 and 46). A password must be entered before these can be used. The password is **9900** followed by the **Enter** key.

### 5.3.2 Statistics menu

Press the **1** key on the numeric pad (or the **OK** key) to access this menu to show –



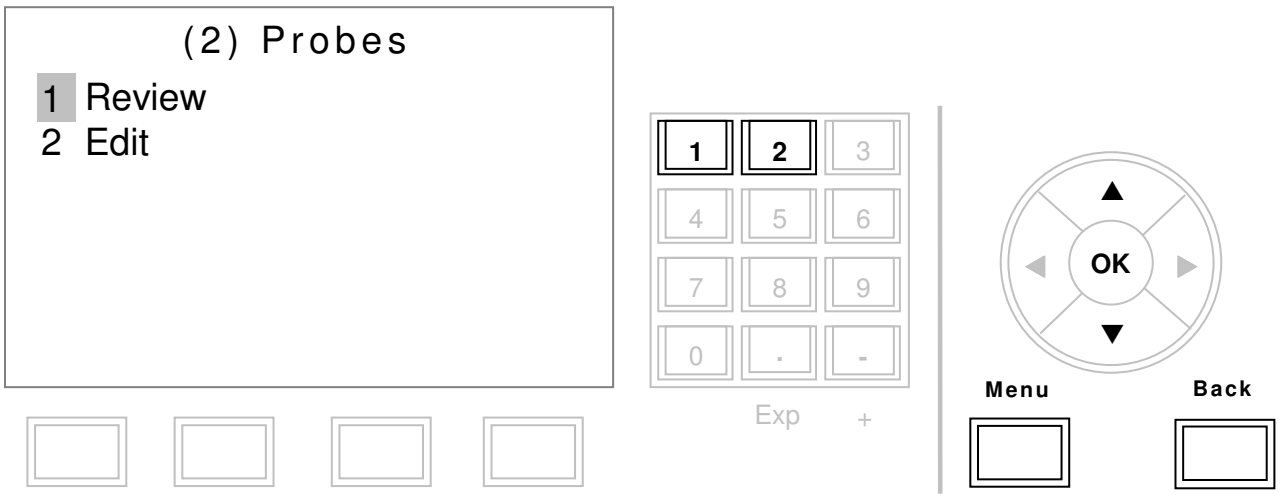

The **Back** soft-key may be used to reset and restart statistical calculation. Press the **Menu** key to return to measurement mode or press the **Back** key to return to top level menu.

.

### 5.3.3 Probe (Review) menu

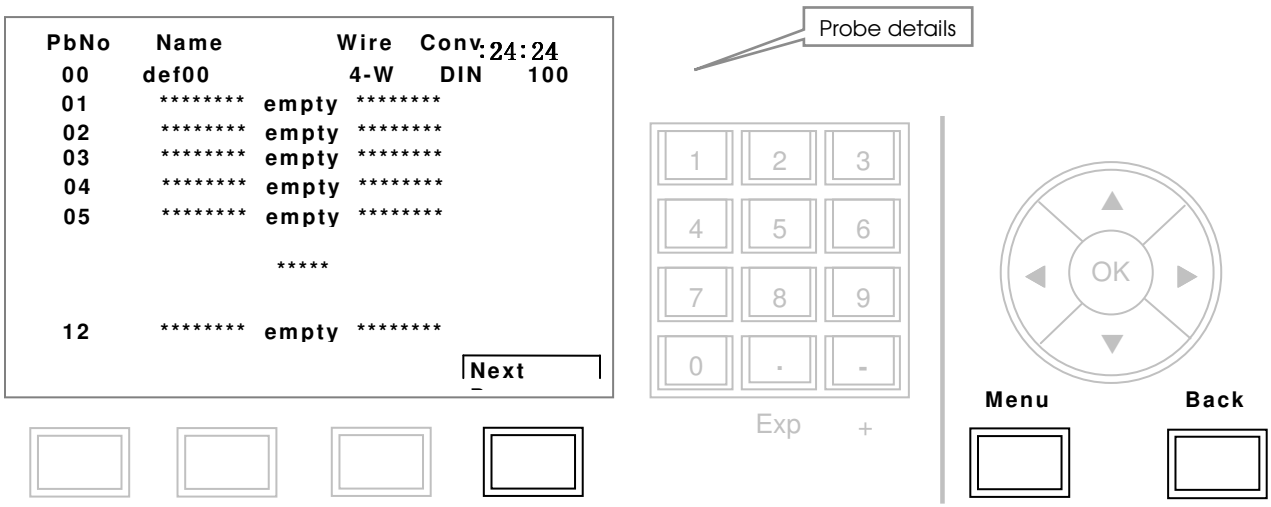
This menu is used to Review probe information. All probes used on the F600 must have the correct data entered to accurately perform the resistance to temperature conversion.

Press the **2** key on the numeric pad or use the up and down keys to navigate to the Probe Menu and press the **OK** key to access this menu.




Press the **1** key (or the **OK** key) to Review the previously entered probe data.

Probe identification is shown on the top line, followed by the type (4-wire)[18] and the resistance to temperature conversion method (DIN). The coefficients for the conversion method are shown below the probe type.




[18] 3-wire measurement is only available when using an external multiplexer unit.

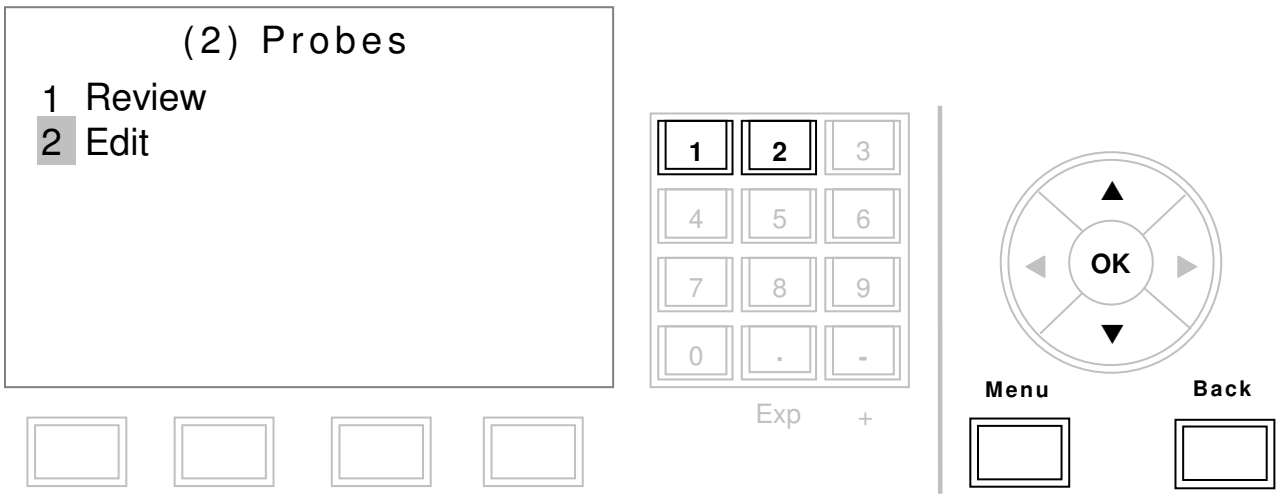
Use the **Next Page** and **Last Page** soft-keys to move between pages to review information about all the probes (**Last Page** will appear once the **Next Page** key is pressed).

Press the **Menu** key to return to measurement mode or the **Back** key to return to the previous menu.

### 5.3.4 Probe (Edit) menu

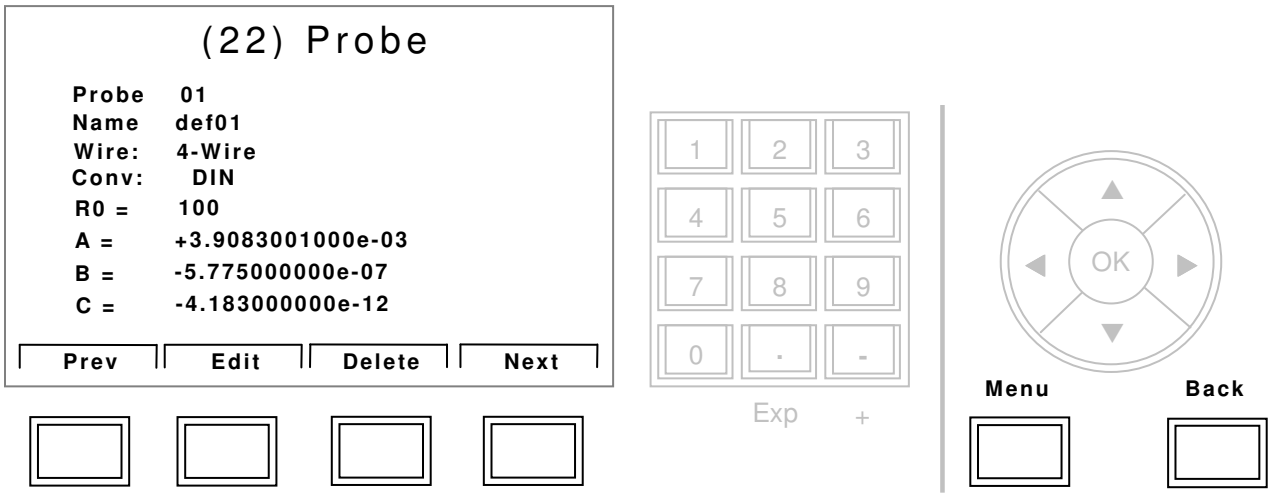
All probes used on the F600 **must** have the correct data entered to accurately perform the resistance to temperature conversion.

Press the **2** key on the numeric pad or use the up and down keys to navigate to the Probe Menu and press the **OK** key to access this menu.




Use the **Prev** and **Next** soft-keys to move between pages to review information about all the current probes.

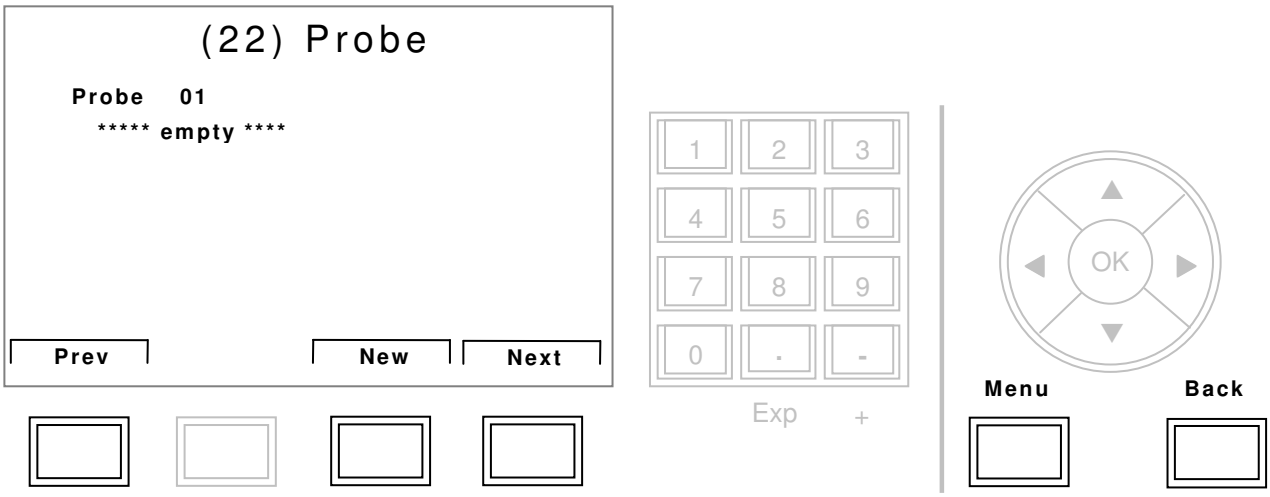
Move to any probe other than **Prb00**.



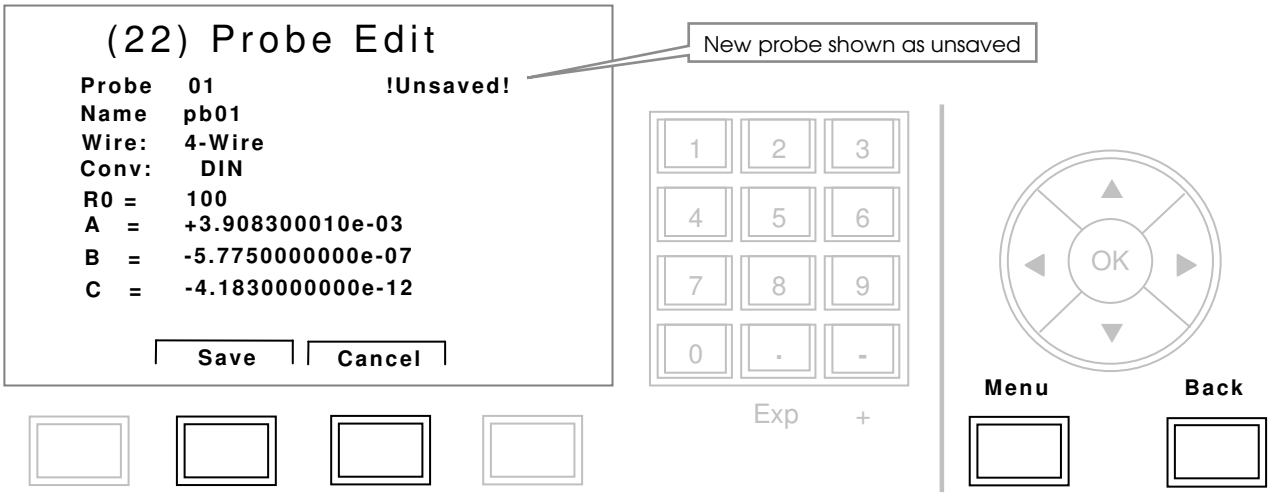
**Note**

**Probe 00** is the default F600 probe. You will not be able to edit details for this probe.

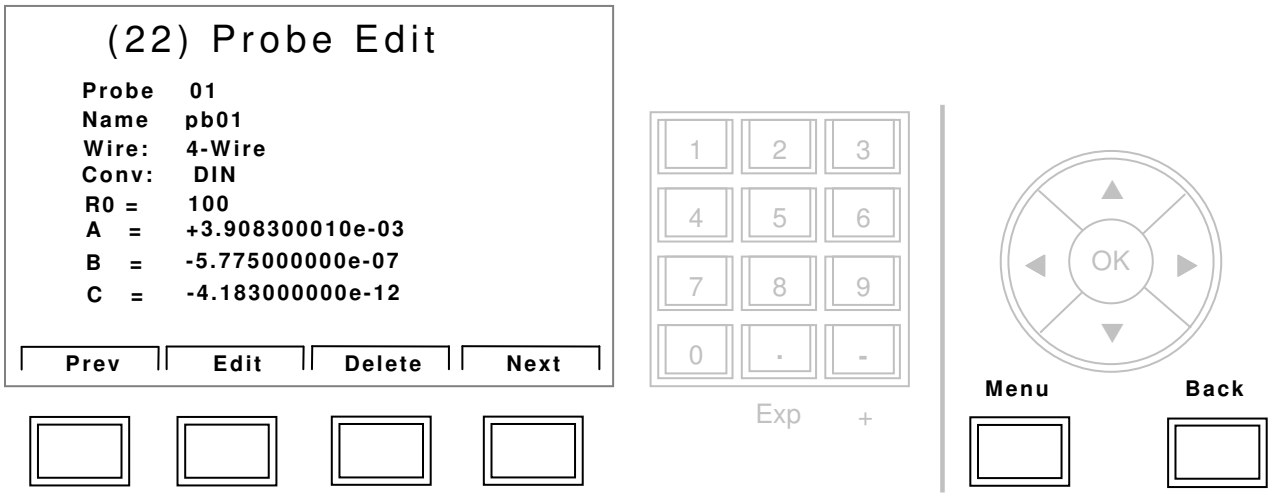
Press the **Next** soft-key to view the next probe's details. The display will change to –



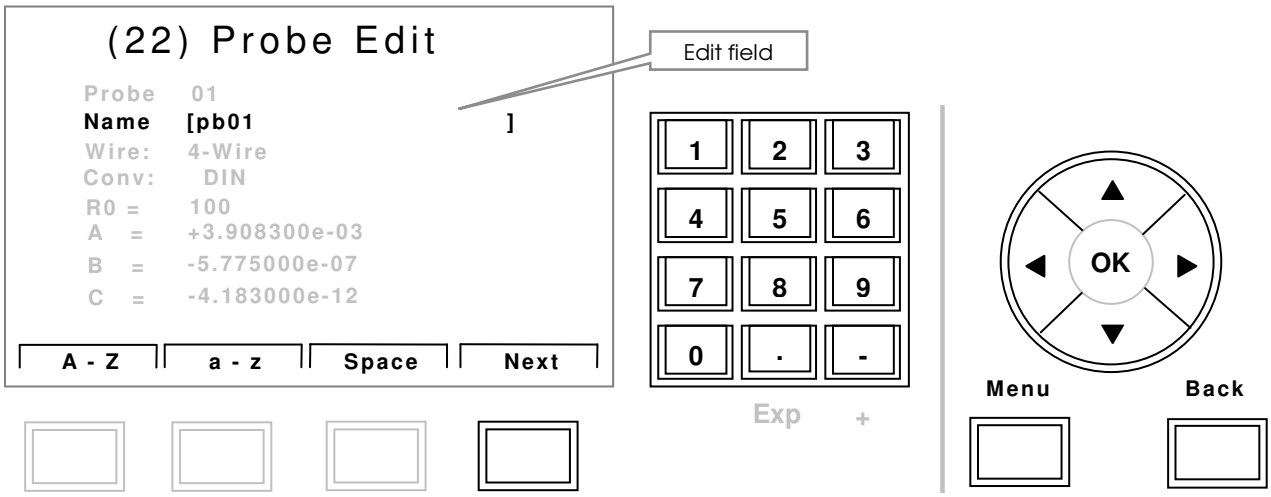

The **New** soft-key will appear. The **New** soft-key will enter a new probe (with the first unassigned number). The display will change to show a new probe with the default system probe settings. If at any time you want to exit the procedure, press the **Menu** or **Back** key - but note that the entries will not be saved.




Press the **Save** soft-key to get to the following screen –




Press the **Edit** soft-key to get to the following screen –

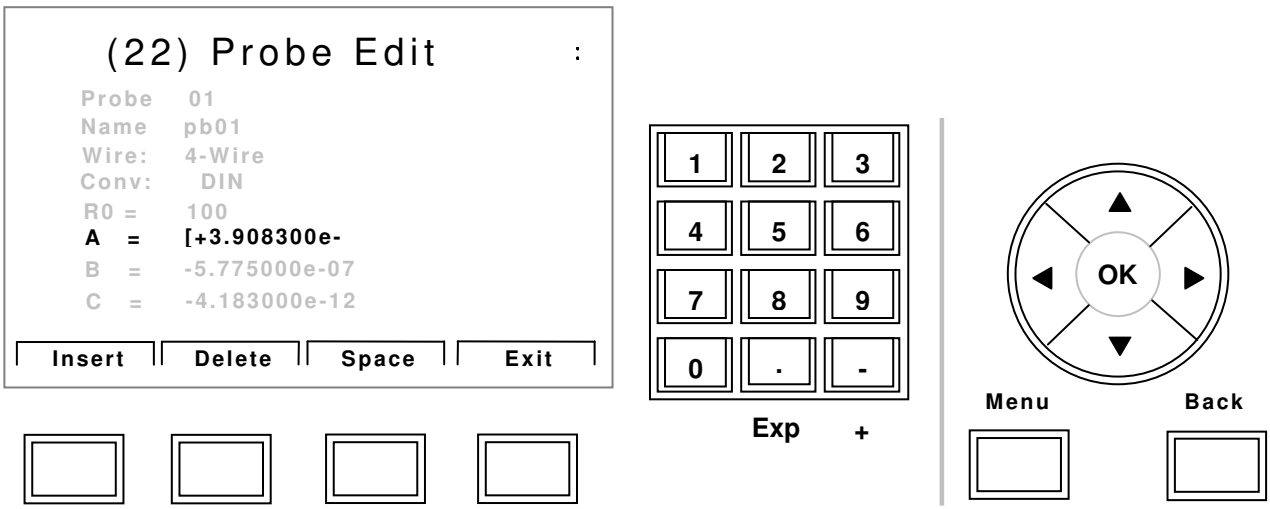



Use the **A – Z** and **z - a** soft-keys to enter the probe's name using the ◀ and ▶ navigation keys to move through the current data field (the field with the `(` and `)` brackets)[19]. Use the ◀ and ▶ navigation keys to move the edit position left or right.

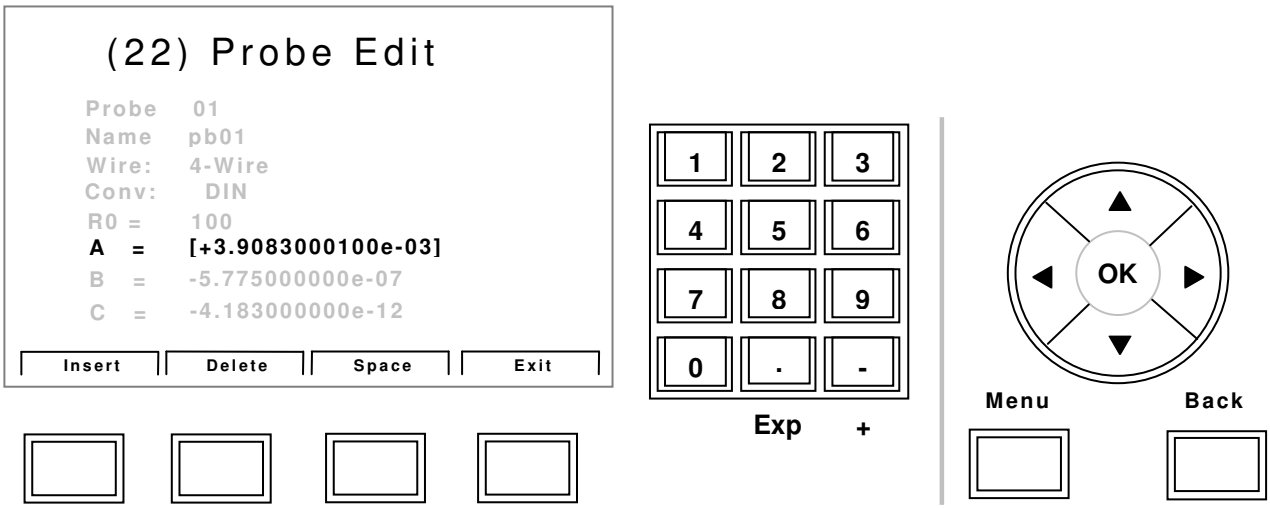
Use the ▲ and ▼ navigation keys to move between fields.

The following display will be shown when one of the numeric edit fields is selected –

[19] These keys are also used to scroll through the available options on the Wire and DIN fields. The 3-Wire option will be used for new switch-boxes.




Press the **Insert** key, and the following screen will be displayed –




The remaining digits may be edited/added or changed as required using the numeric keypad.

The function of the various editing soft-keys is fairly obvious (described by their legends). If pressed, the **Insert** soft-key will change to **Overtype**. If **Insert** is then pressed it will revert to **Overtype**. The **Insert** key allows you to inset a digit and the **Delete** key to erase a digit. The **Space** key inserts a blank digit. The **Overtype** key changes the selected digit and the **Backspace** key moves one digit to the left with deletion (if possible). The **Exp** shift-key is used to insert an exponent - use the shift key to select this (instead of the decimal place).

Press the **OK** key to accept and save the results of the edit. Alternatively, move the edit field up or down to leave the results unchanged.

Press the **Exit** soft-key once all the probe data has been entered and then press the **Save** key to save the probe data.

Data entry is similar for the other temperature conversion methods.

Press the **Menu** or **Back** key once you have entered all the data.

**Note**

Failure to accurately enter the correct probe-type and its associated calibration data will lead to inaccurate (or wrong) resistance to temperature conversion calculations.

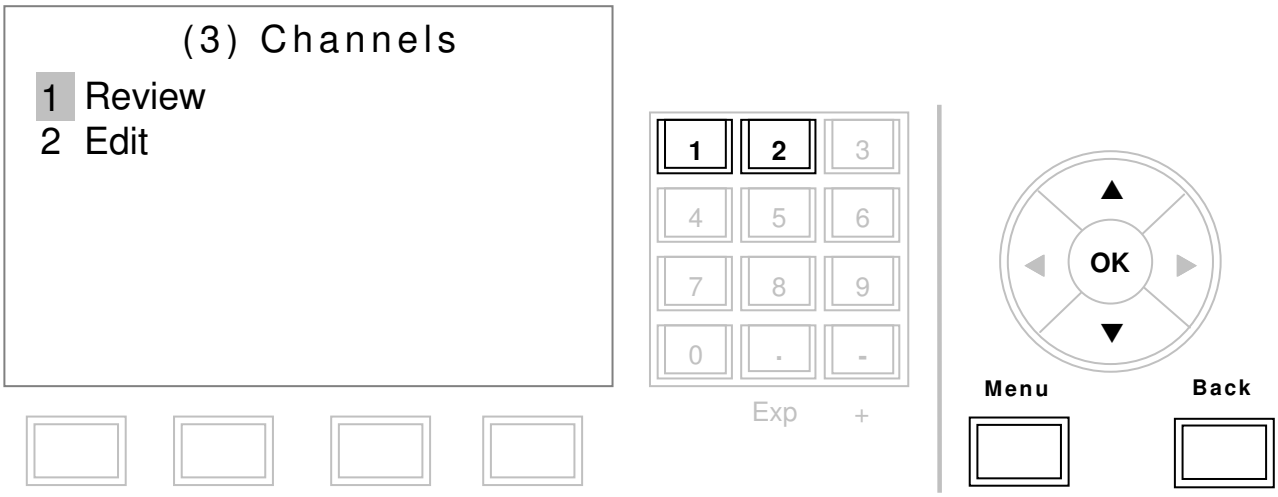
**Note**

The numeric keypad may be used to move directly to a probe number. This is easier thatn moving one probe at a time in some circumstances.

### 5.3.5 Channels (Review) menu

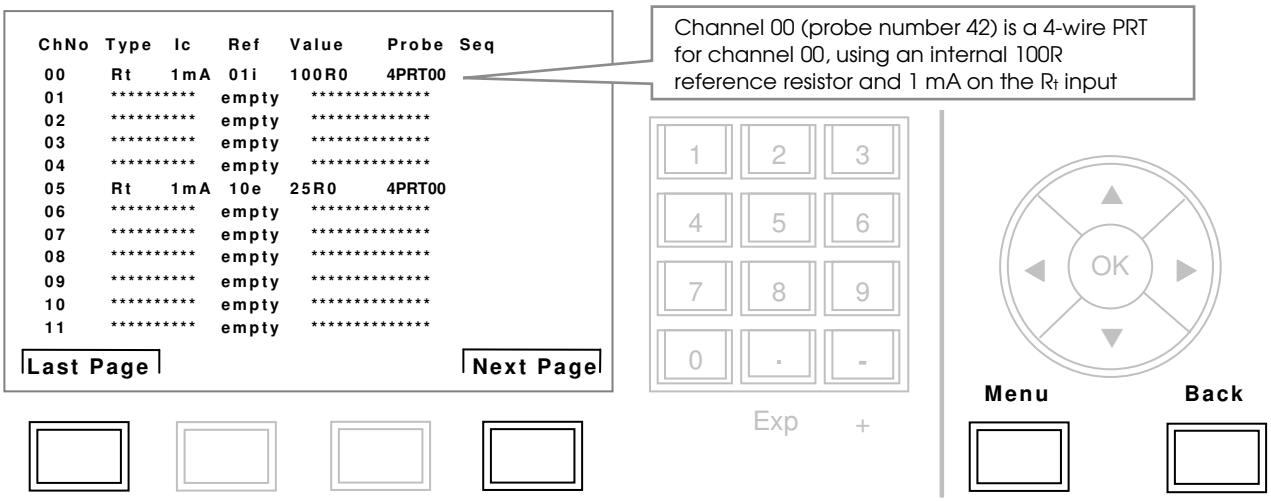
A channel holds a complete instrumental setup under its identification number. This menu may be used to Review individual channel information.

Press the **1** key on the numeric pad or use the up and down keys to navigate to the Channel Menu and press the **OK** key to access this menu.




Press the **1** key (or the **OK** key) to Review the previously entered channel data.

Use the **Last Page** (not visible on the first page) and **Next Page** soft-keys to move between pages to review channel information. The screen below shows that channel 00 (system default) and channel 05 have been set (and their associated values).



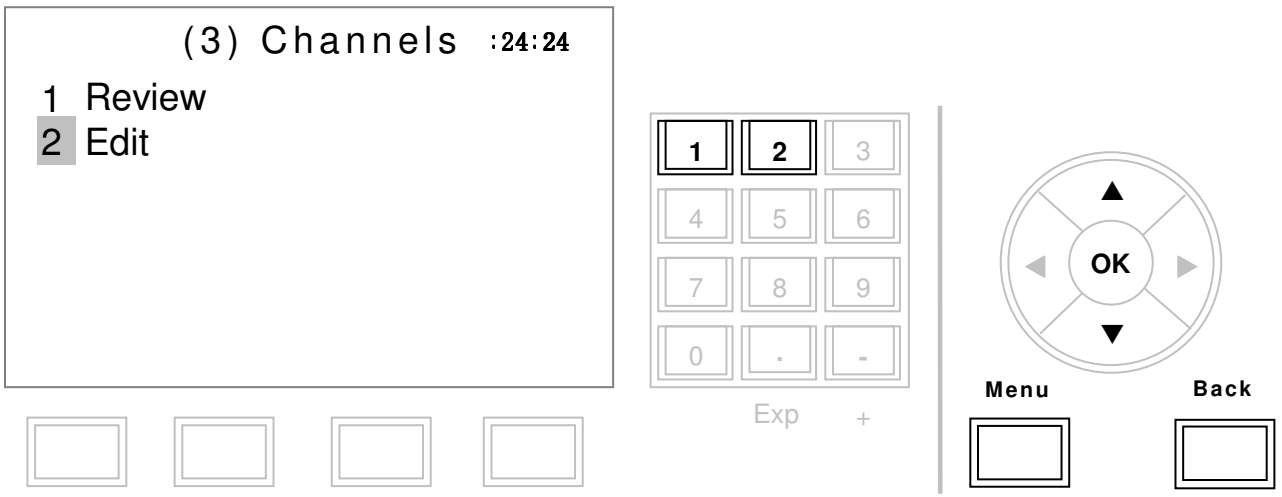

Press the **Menu** key to return to measurement mode or the **Back** key to return to the previous menu.

### 5.3.6 Channels (Edit) menu

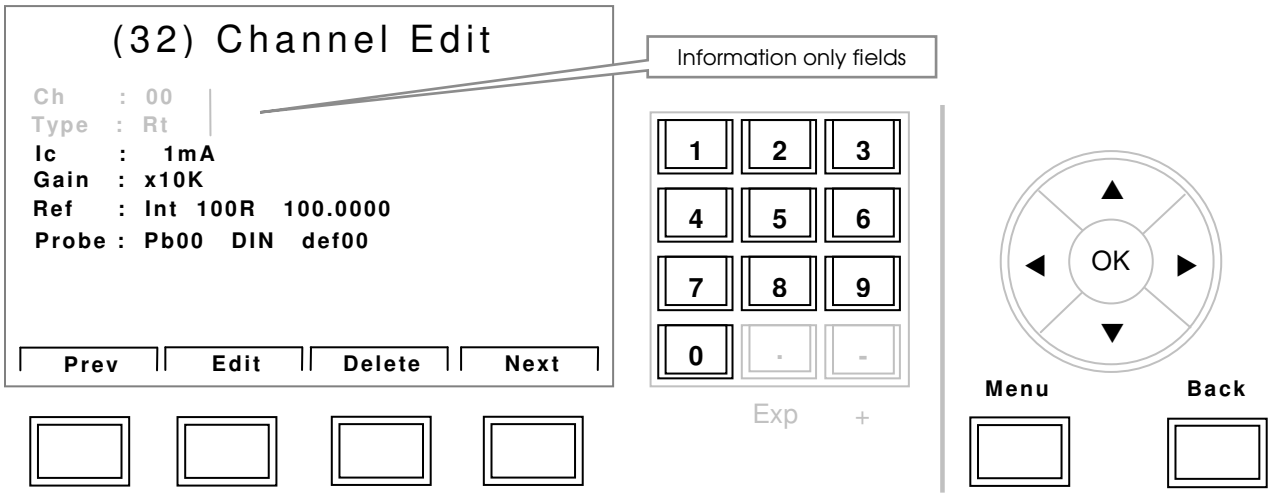
A channel holds a channels setup under its identification number. This menu may be used to Edit individual channel information.

Channels may be set to either measurement ($R_t$) or reference ($R_s$) types.

Press the **2** key on the numeric pad or use the up and down keys to navigate to the Channel Menu and press the **OK** key to access this menu.

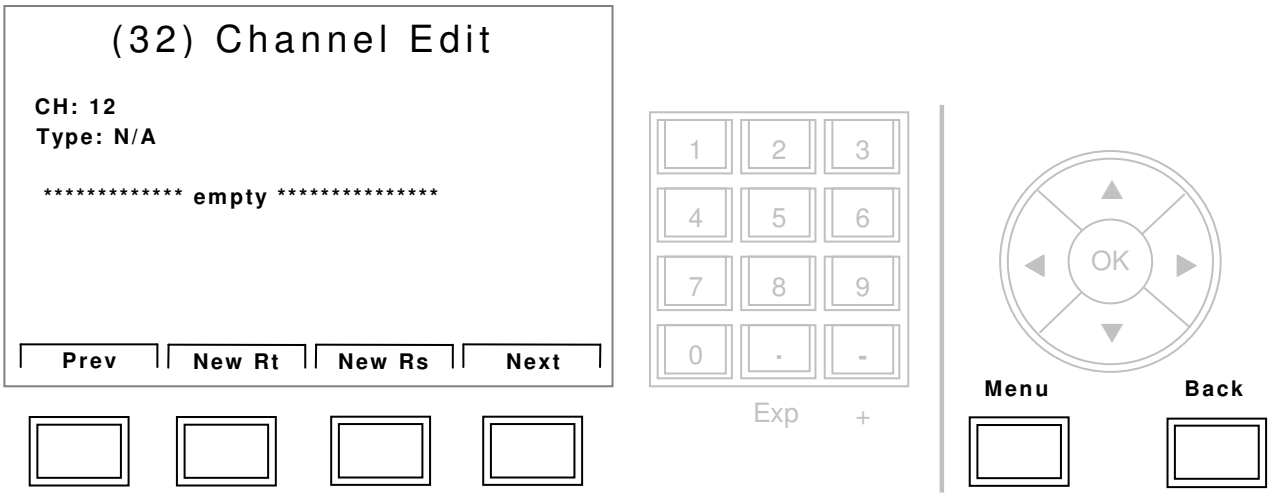



Press the **2** key (or the ▼ navigation and **OK** key) to Edit the channel information.

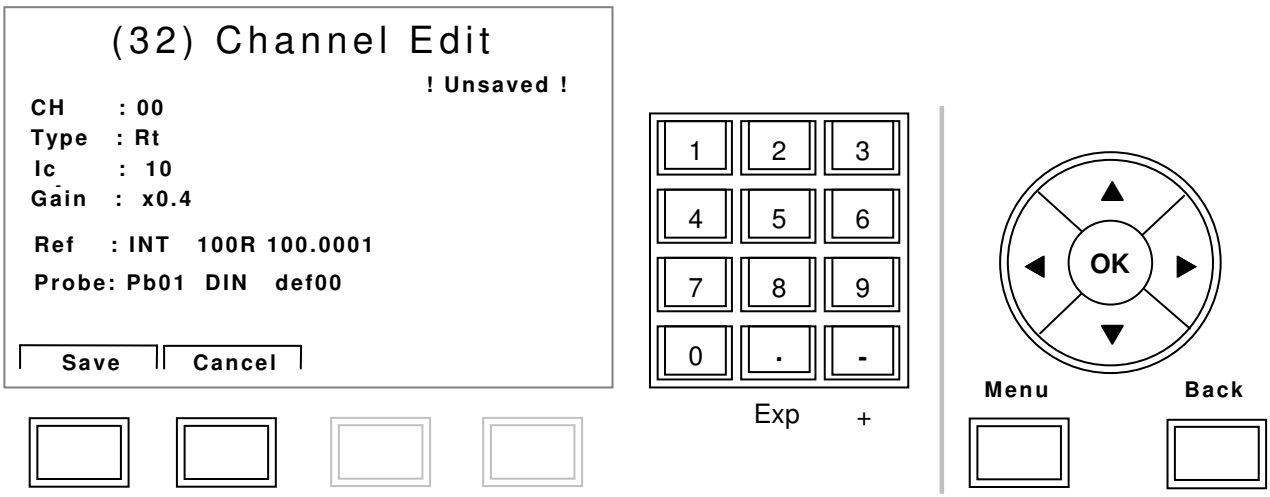


The first two fields are for information only (they cannot be edited). Use the **Prev** and **Next** soft-keys to move through the pages for all 99 channels[20]. Channels that have been entered will look similar to the example above.

Unused channels will look similar to the one below –



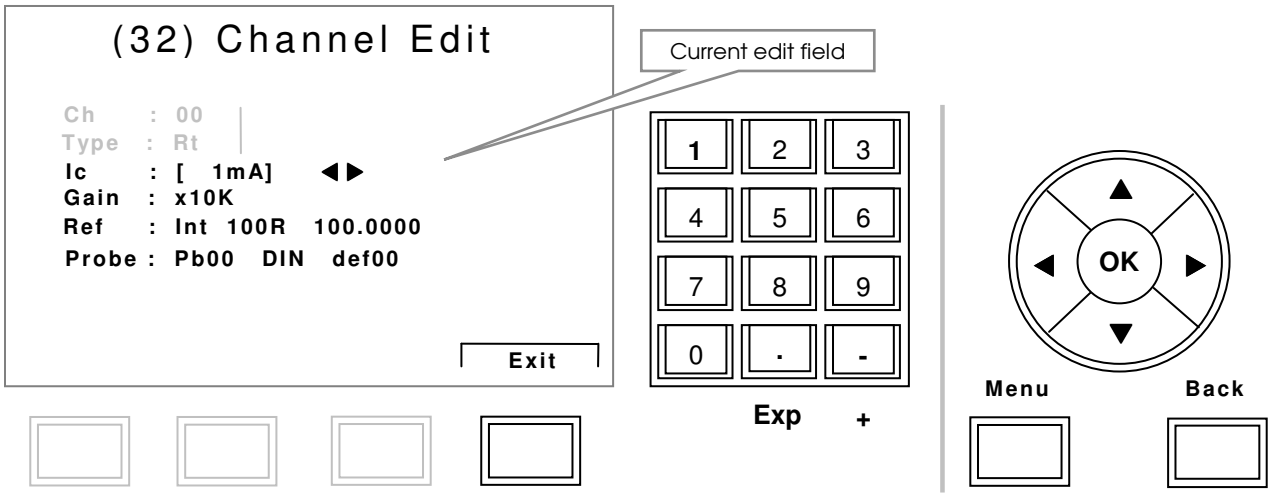

Empty channels may be used. For example, press the **New Rt** soft-key to see the screen below –




Select **Save** or **Cancel** as required. If **Cancel** is selected, the screen will change back to the previous one, allowing you to select another channel for editing.

[20] Alternatively, type in the channel number using the numeric keypad.

A new channel may be edited once it has been saved. Once the channel exits, the edit-screen will be similar to -



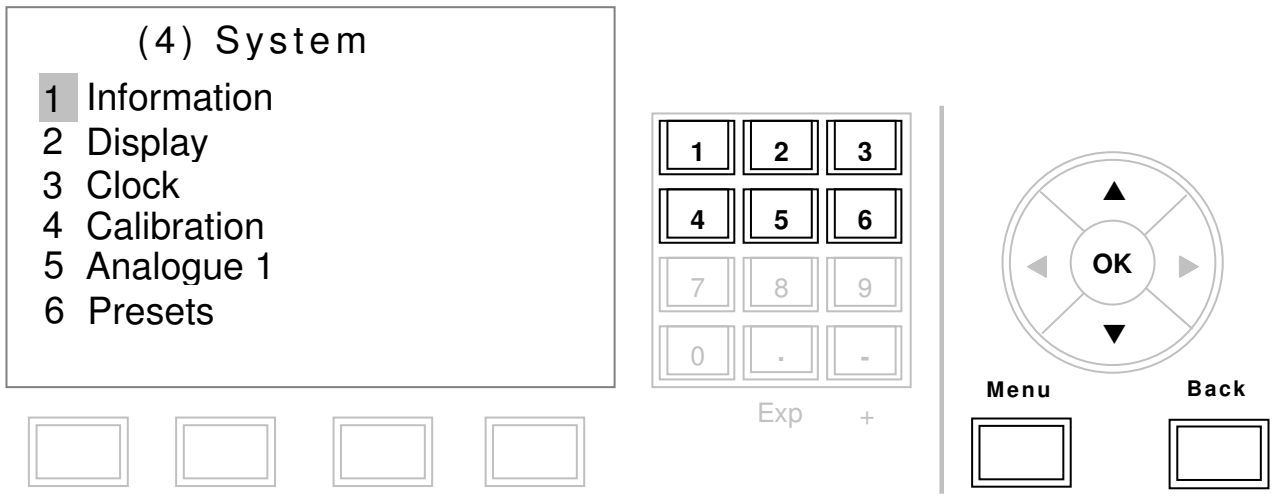

The square brackets are shown around the first editable field. The editing functions and procedures are now identical to those associated with probe editing – see section 5.3.4 for complete details on changing and entering data. Use the **Back** soft-key to return to the previous screen, if necessary.

Edit the fields, as required, before pressing the **Exit** soft.

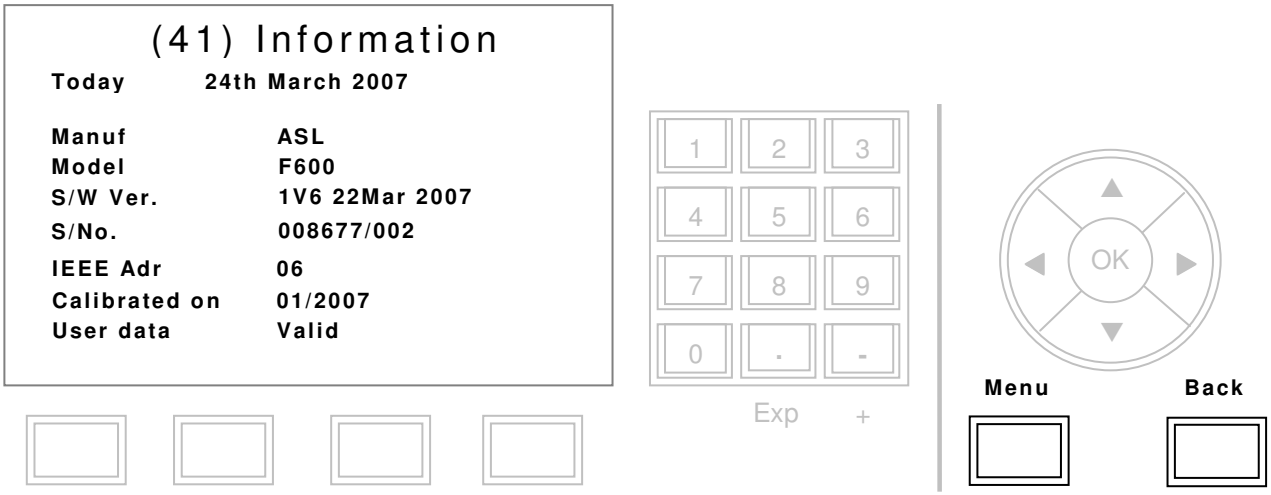
### 5.3.7 System menu

This menu displays useful information about dates and version numbers.

Press the **4** key on the numeric pad (or use the up and down keys to navigate to the System Menu and press the **OK** key) to access this menu. The display will change to show –




Press the **1** key or the **OK** key to display the system Information screen –

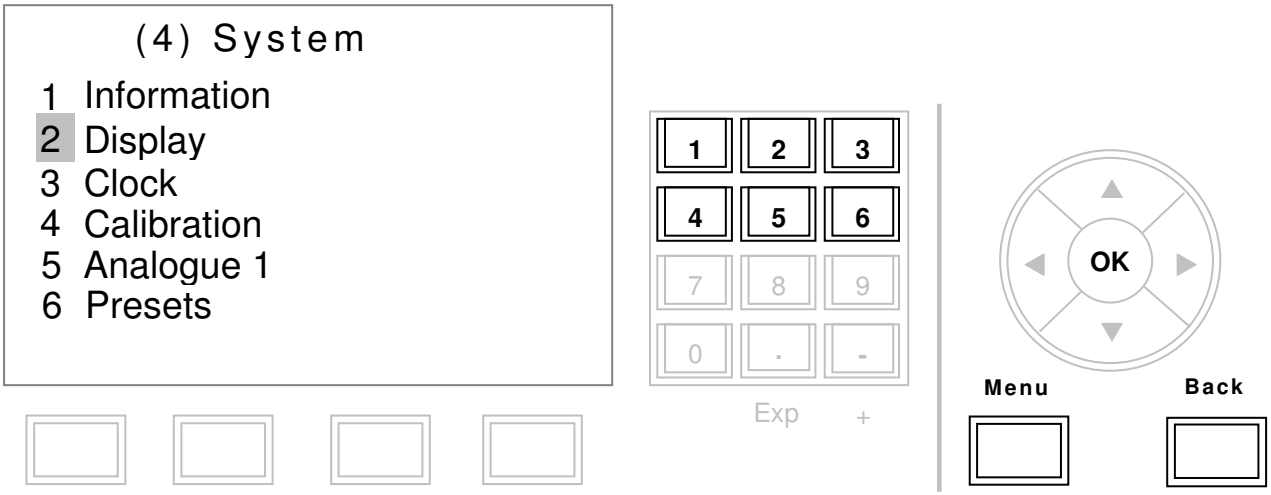



Press the **Menu** key to return to measurement mode or the **Back** key to return to the previous menu. Note that the IEEE address is only shown when the interface is installed.

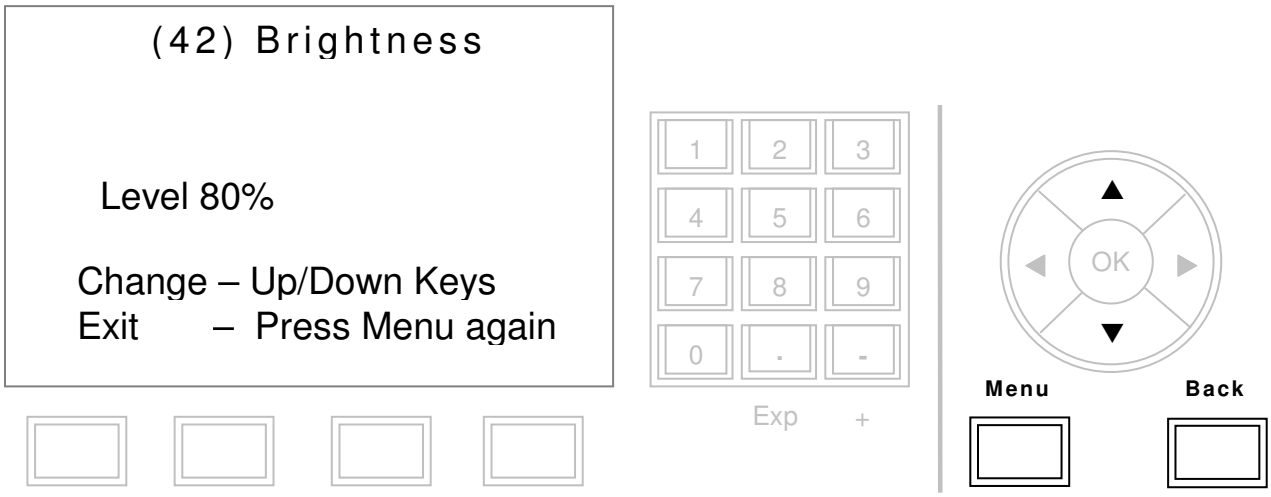
### 5.3.8 Display menu

This menu is used to set the desired display brightness level.

Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Display menu as shown below.




Press the **2** key or the **OK** key to get to this screen –

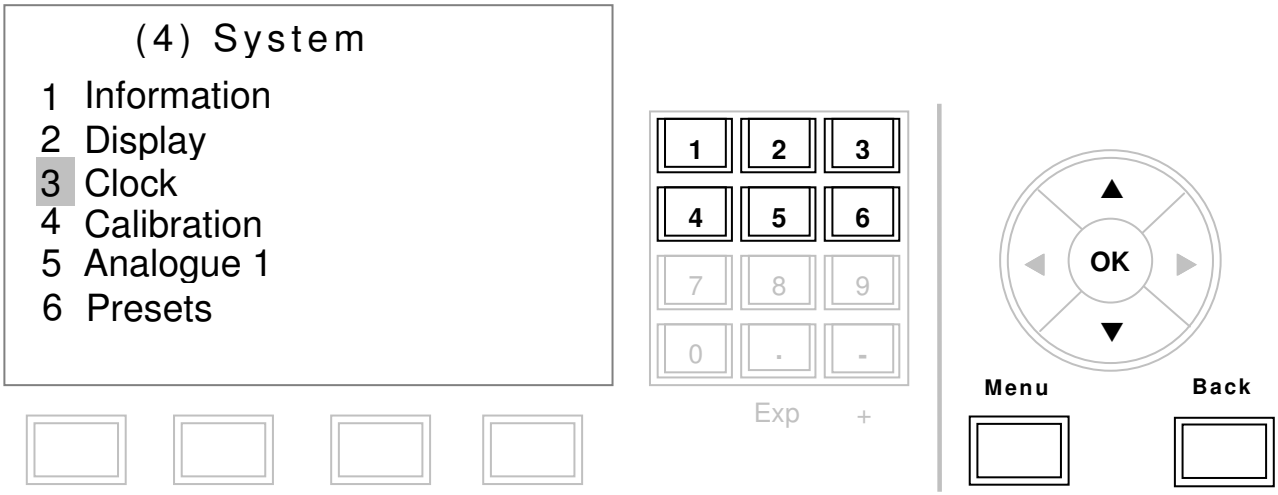



Use the ▲ and ▼ navigation keys to set the brightness to the desired value. Press the **Menu** key to accept the value and return to measurement mode or the **Back** key to return to the previous menu.

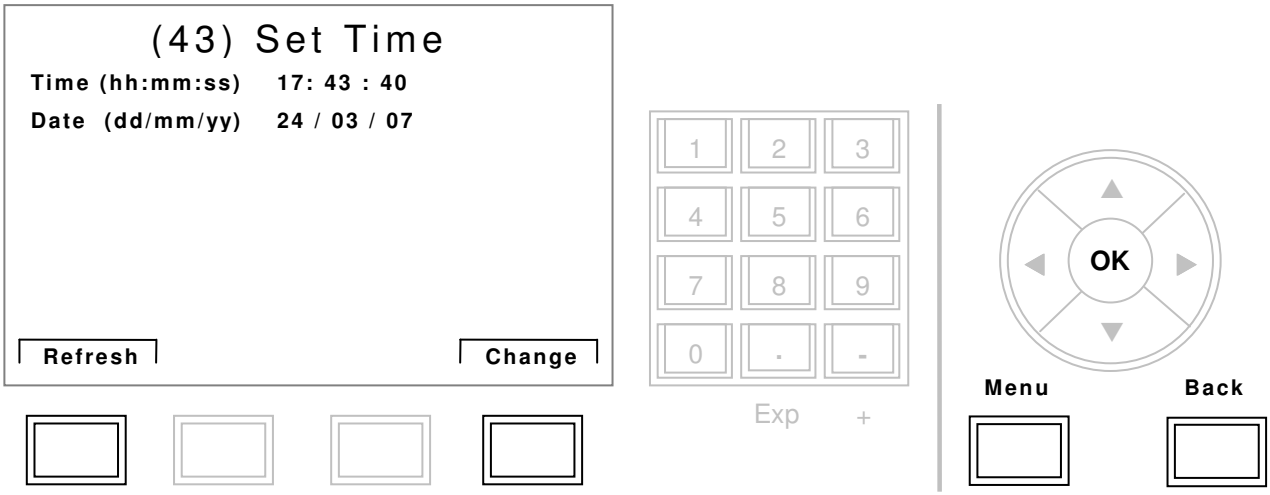
### 5.3.9 Clock menu

This menu is used to set the current date and time.

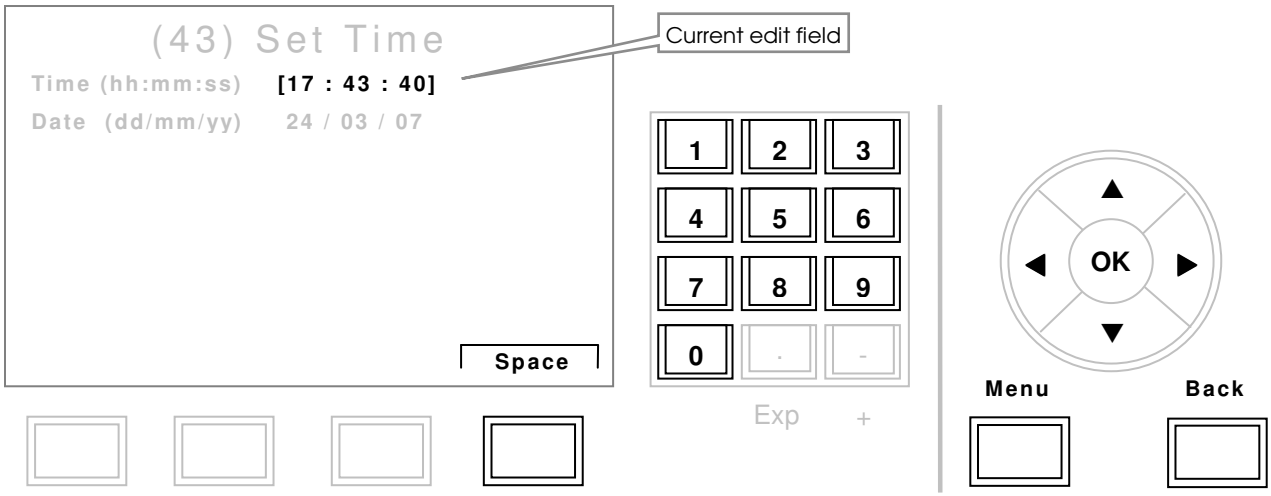
Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Clock menu as shown below.




Press the **3** key or the **OK** key to set the time and/or date –



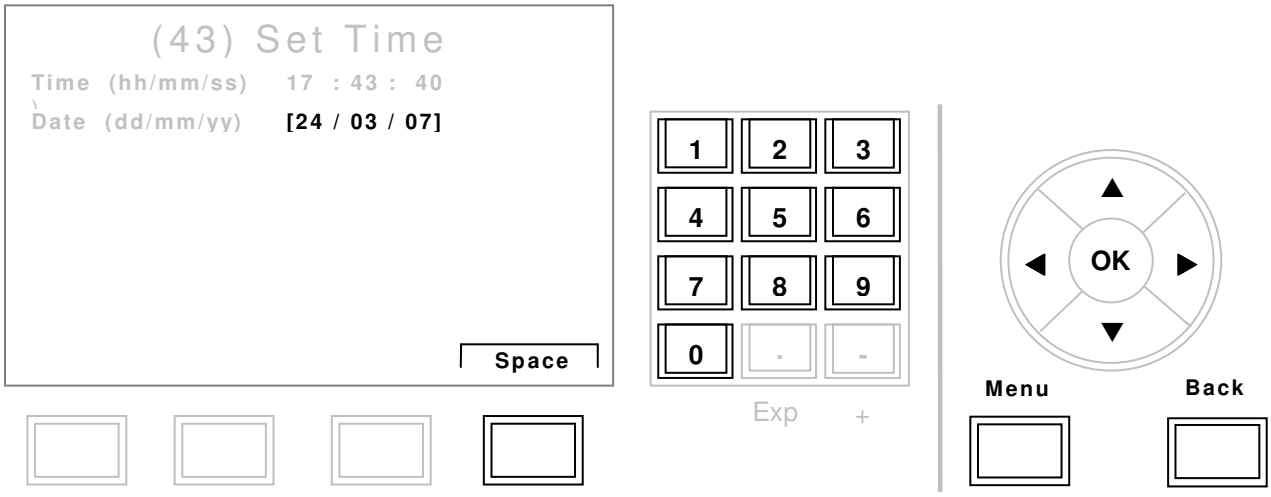

The **Refresh** soft-key is used to show the current time and date (time and date are frozen on entry so that they can be easily edited). Press the **Change** soft-key to alter the settings. The display will change to show –




The display has changed to show the `**(**' and **')**' brackets around the current edit field (the time). The ◀ and ▶ keys are used to move the cursor to the left or right; edit the time and press **OK** (press the **Back** to exit without changing the time). Use the numeric keypad to change the current edit field values. The ▲ and ▼ keys swap between time and date fields.

Press the **OK** key once the entry within the currently selected field is correct; this returns the action of the ▲ and ▼ keys to moving between fields.

The **Space** soft key clears the numbers in the current field.

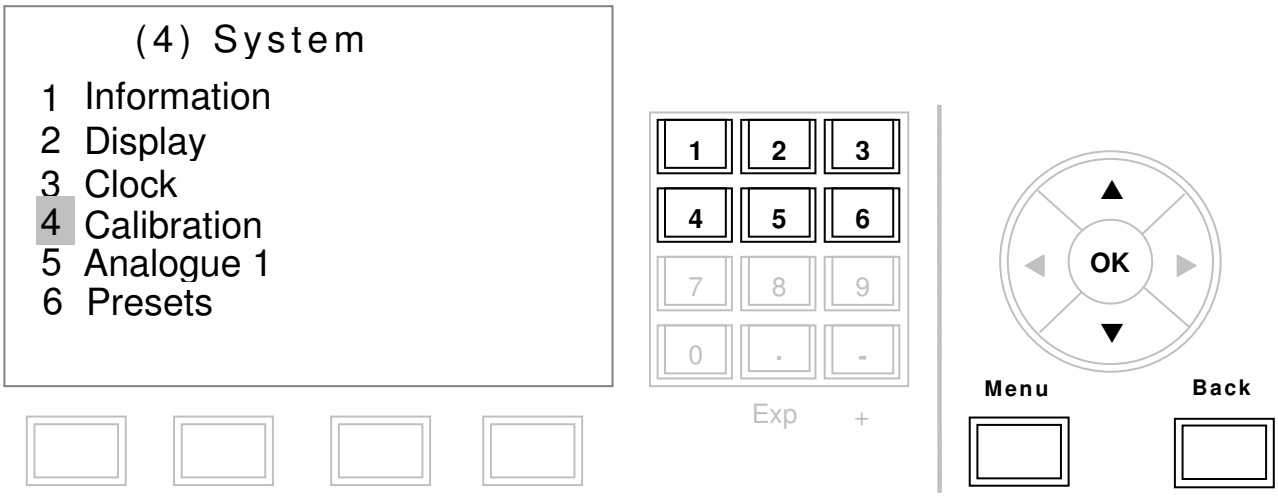



Once you are happy with all the field-entries, press the **Menu** key to accept the value and return to measurement mode or press the **Back** key to return to the previous menu without setting the clock.

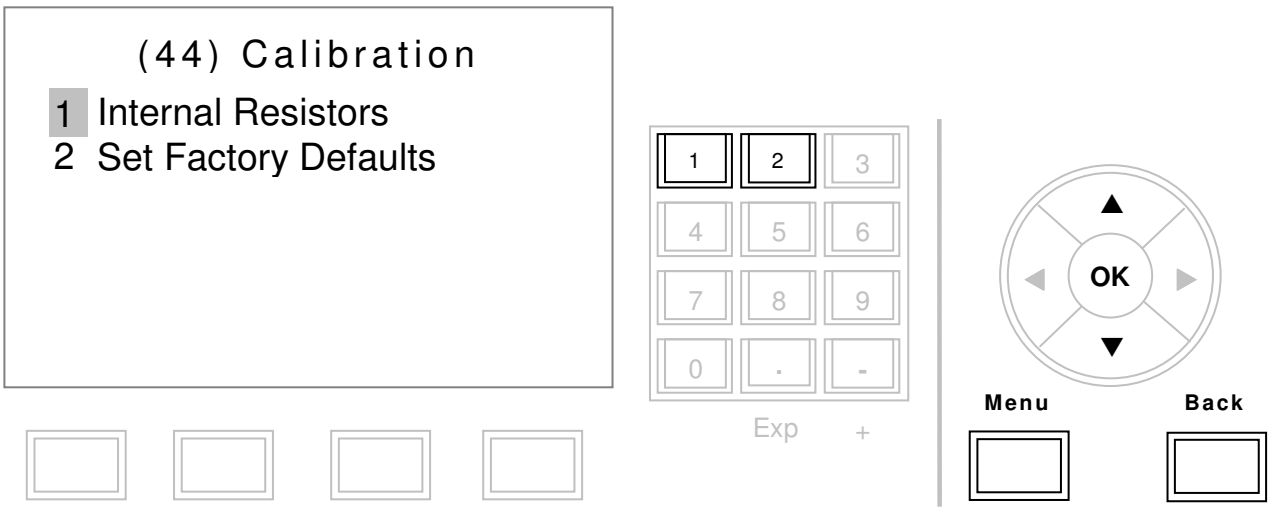
### 5.3.10 Calibration (Internal Rs) menu

This menu is used to set the calibrated values of the internal reference resistors and to reset the F600 to its factory default setting.

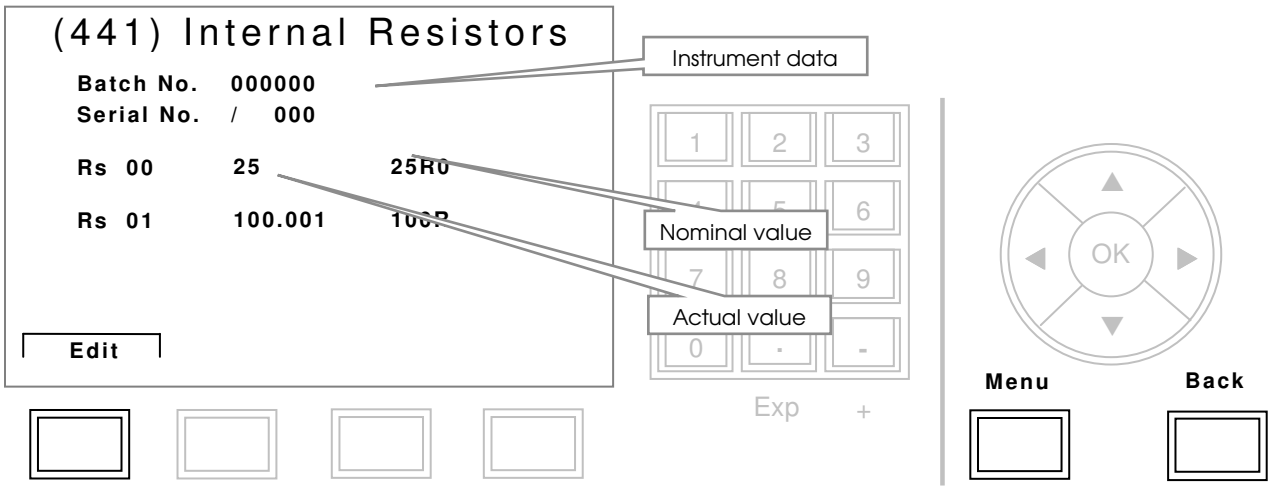
Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Calibration menu as shown below.



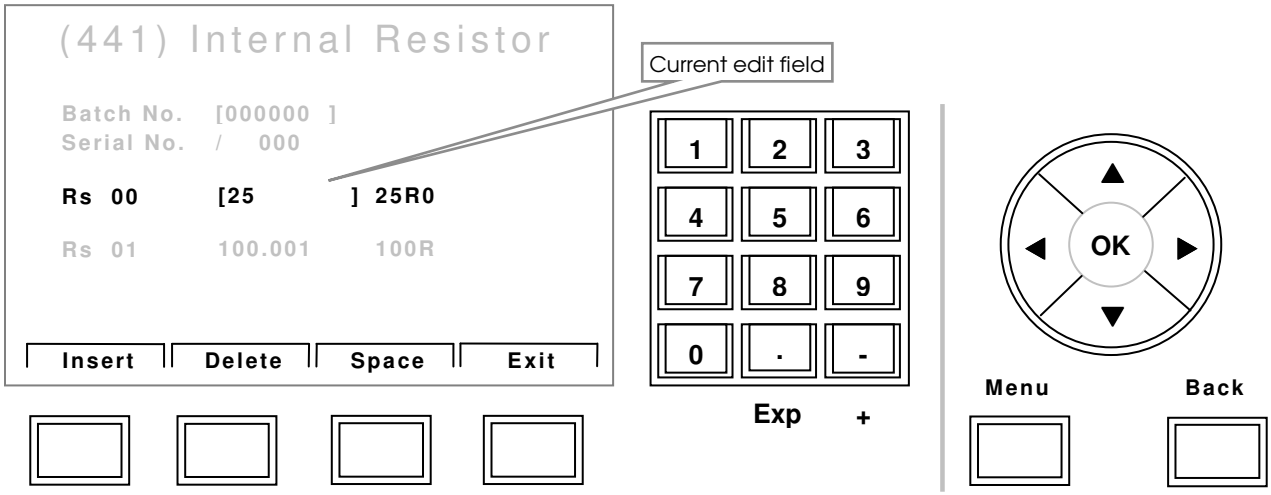

Press the **4** key or the **OK** key to see the menu –




Press the **1** key or the **OK** key to see the calibration menu for the internal resistors (data entry for the instrument serial number is also shown on this screen) -




Use the ▼ key to move to the required resistor value. Press the **Edit** soft-key to adjust the internal calibration resistance values[21]. The screen will change to show -




Use the Work out the adjusted resistance value that must be entered, based on the actual calibration resistor value. This is most easily done by first setting the internal calibration value ($R_{Int}$) to the nominal resistor value ($R_{Nom}$), measuring the value ($R_{Obs}$) and then entering the calibration resistance value calculated from –

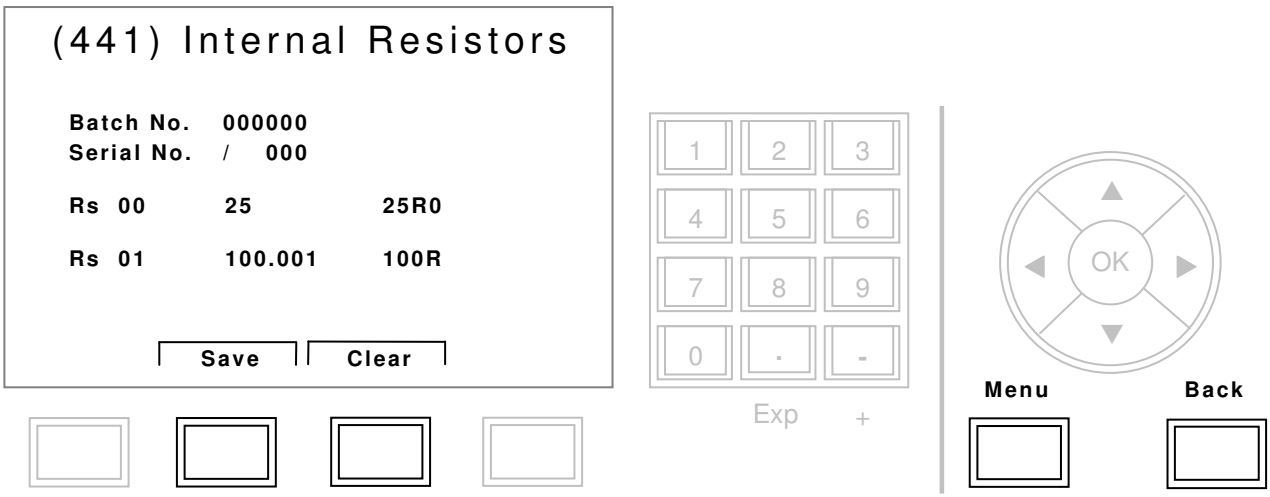
$$R_{Internal} = \left( \frac{R_{Ref}}{R_{Obs}} * R_{Nom} \right)$$

[21] Note that these will be recorded on the test certificate that comes with the instrument.

The editing process is identical to the one used in section 5.3.4. Edit the current field and note that the nominal field will automatically be adjusted to follow it (3 significant digits shown).

Press the **OK** key once you are happy with the new value. Edit the remaining values, as required before pressing the **Exit** soft-key.

The screen, for example, will change to show –




Press the **Save** soft-key to keep the change(s) or press the **Back** (or **Clear**) soft-key to prevent any changes from being applied. Press the **Menu** key to end editing (or the **Back** key to return to the previous menu).

The nominal internal resistors values (fitted as standard) are 25 ohms and 100 ohms.

**Note**

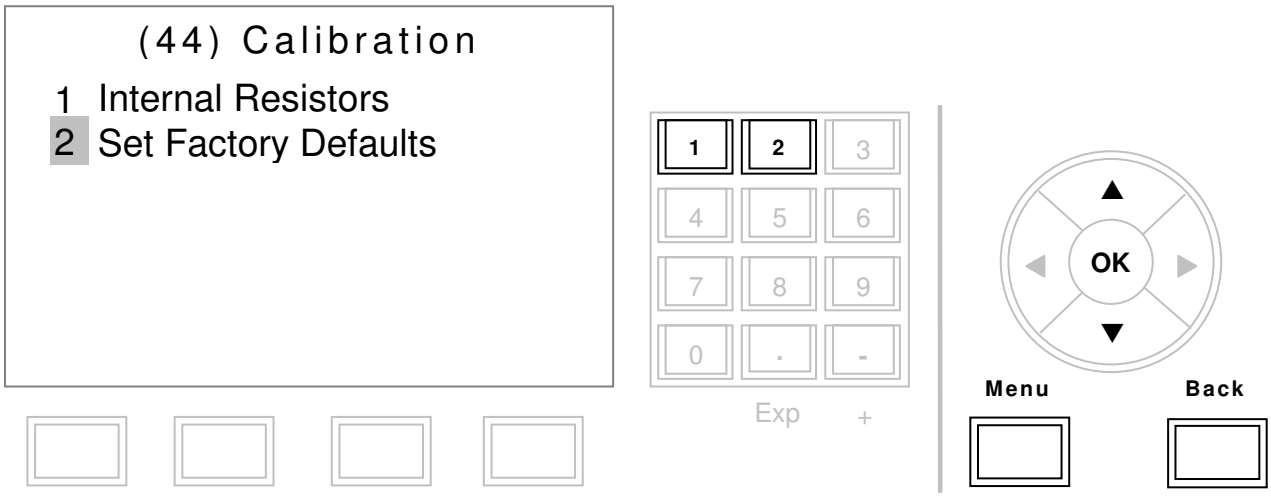
The calibration values are held in non-volatile memory inside the F600. The instrument MUST be switched off and on again for the new calibration values to take effect.

### 5.3.11 Calibration (Factory Defaults) menu

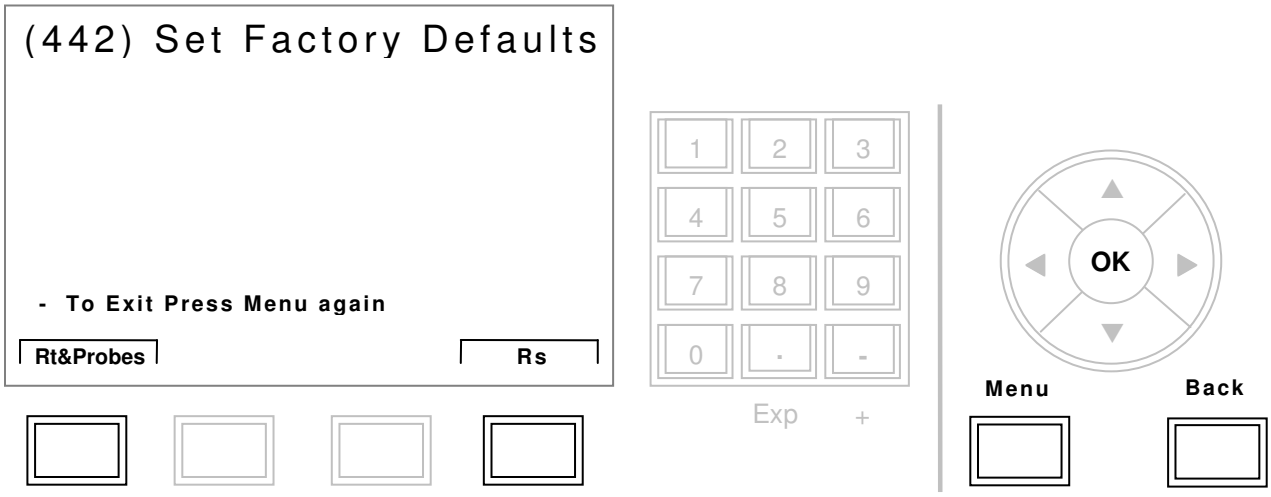
This menu clears the factory default settings for the internal resistors and probes and also for the external references.

| Note |
| --- |
| Use this menu with care. |
| **ALL** values entered into the F600 will be cleared. |

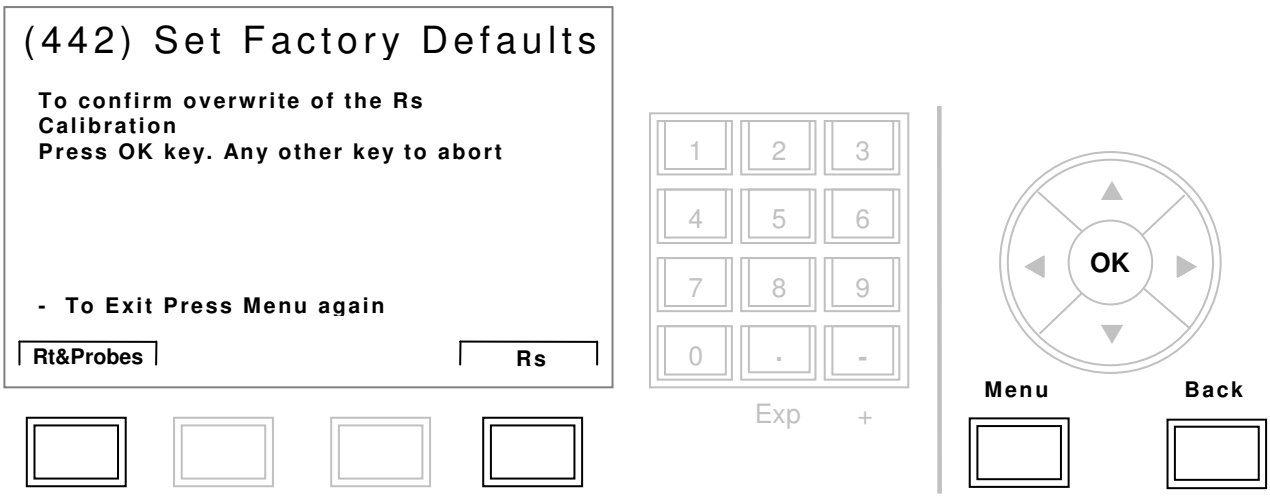
Press the **4** key or the **OK** key to see the calibration menu –-



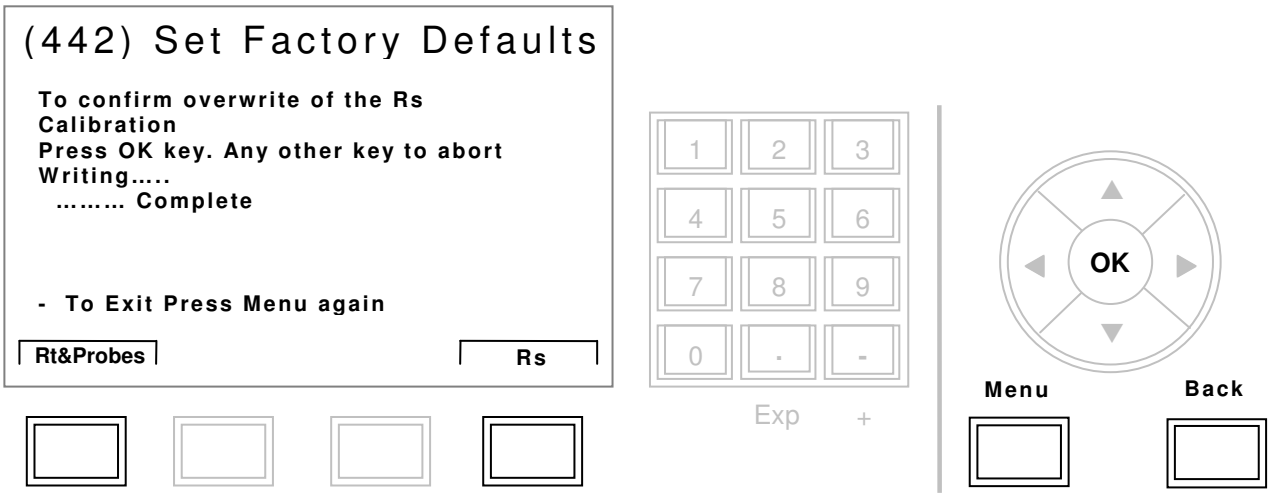

Press the **2** key (or use the navigation keys) and press the **OK** key to select the Set Factory Defaults menu.



Either press the **Rt&Probes** soft-key or the **Rs** soft-key. For example, pressing the **Rt** key will show –




Either press the **OK** (or any other key) to prevent overwriting. If the **OK** key is pressed then the following screen will be seen after a few seconds.

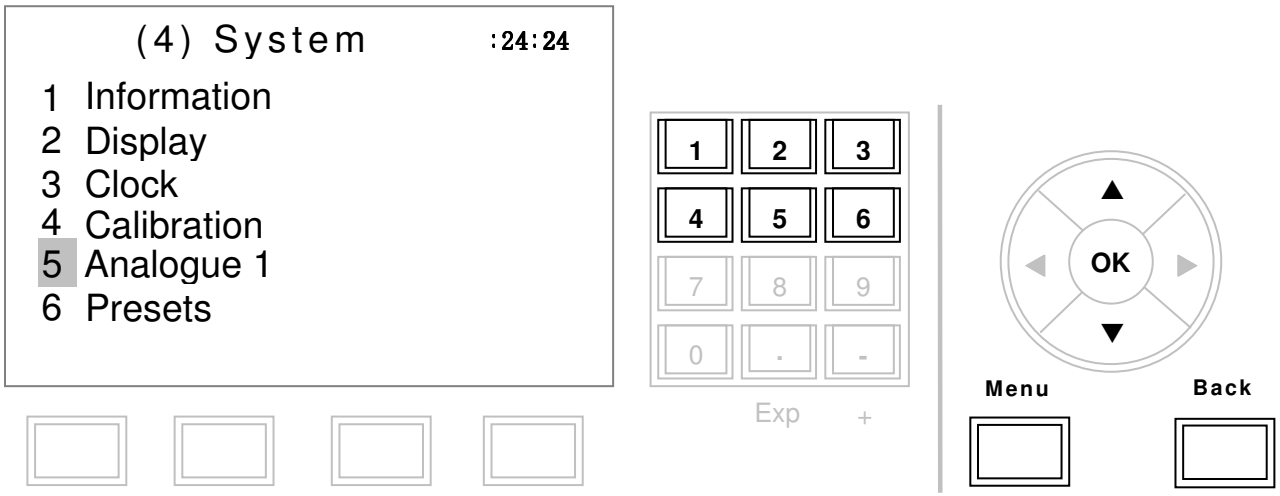



Press the **Menu** to exit or press the **Cancel** key to return to the previous menu.

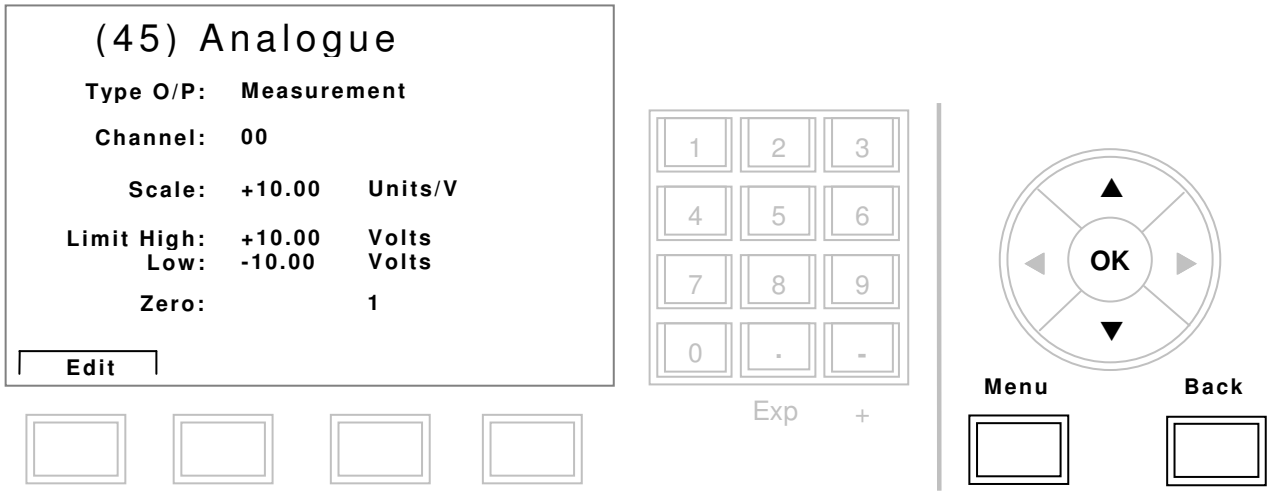
### 5.3.12 Analogue output menu

This menu is used to set the analogue output scaling and offset values for the F600 Bridge.

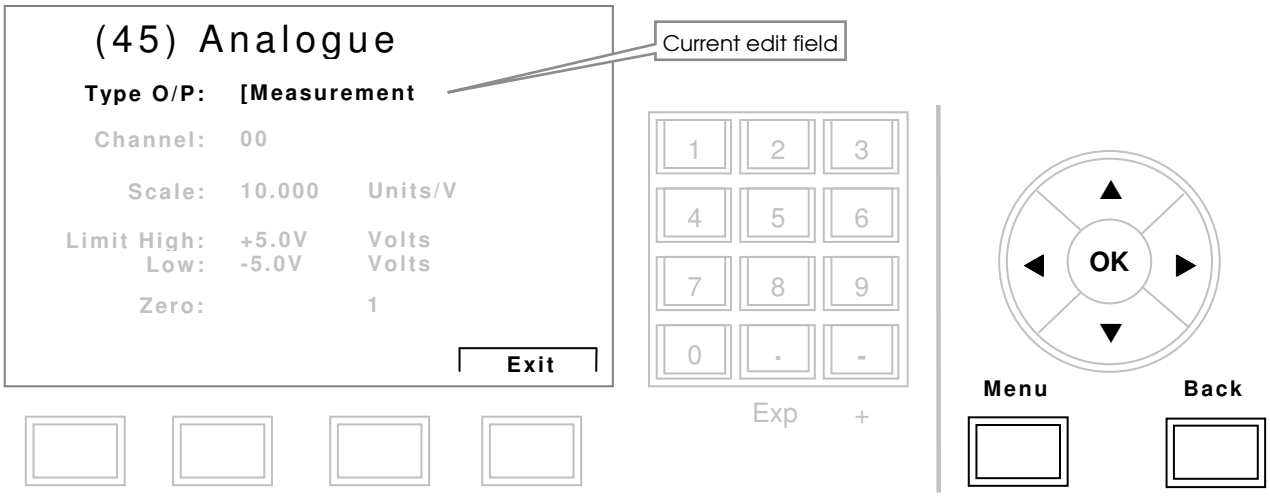
Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Analogue 1 output menu as shown below.




Press the **5** key or the **OK** key to see the current values –




Press the **Edit** soft-key to alter the analogue output values. The screen will change to show -




The display has changed to show the `**(**' and **')**' brackets around the current edit field (the measurement type in this case). The ◀ and ▶ navigation keys are used to move the active edit field. Move to the field that you want to change and press **OK**. The ◀ and ▶ keys will change to moving the cursor within the field. The numeric keypad may be used to change numeric field values. Editing is similar to the Probe Edit screen (see section 5.3.4). Use the ▲ and ▼ navigation keys to change the Measurement field.

**Type O/P**

This field toggles between **Measurement** and **Balance** as the output value. Either the output is based on the current unit Measurement

***Output(V) = ( Measurement - Zero) * Scale***

or the balance error signal is output for the F600AC Bridge

***Output(V) = Balance Error***

**Channel**

Selects channel for which to set the analogue parameters to (0 to 99)

**Scale**

Scale factor for the selected channel in units/volt (+/-1000 to 0.01)

**Limit High**

Sets the maximum output in volts for the selected channel (+10.0 to -10.0V)

**Limit Low**

Sets the minimum output in volts for the selected channel (+10.0 to -10.0V)

**Zero**

Sets the offset value (from 0V) for the selected channel (real or exponential number)

Note that the values of **Zero** and **Scale** are unit-less and will apply to the active channel's units.

For example, to set channel 19 to give ±5V full-scale output based around +1V (i.e. a full-scale output between +6V and -4V), set the valiues to –

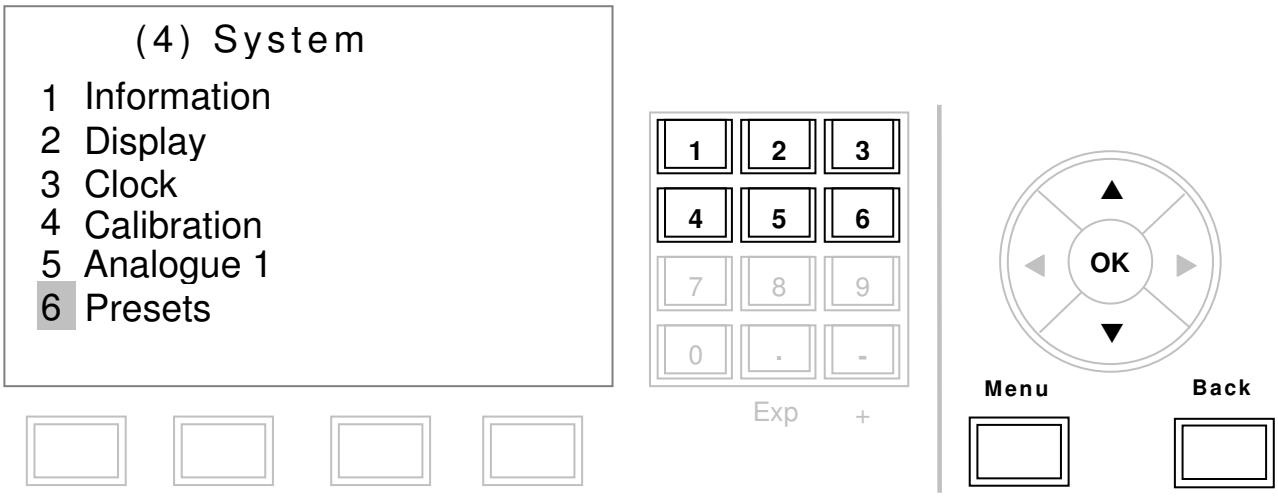
**Type O/P** =Measurement
**Channel** = 19
**Scale** = 0.5
**Limit High** = +6V
**Limit Low** = -4V
**Zero** = +1V

Once you are happy with all the field-entries, press the **Menu** key to accept the value and return to measurement mode or press the **Back** key to return to the previous menu.

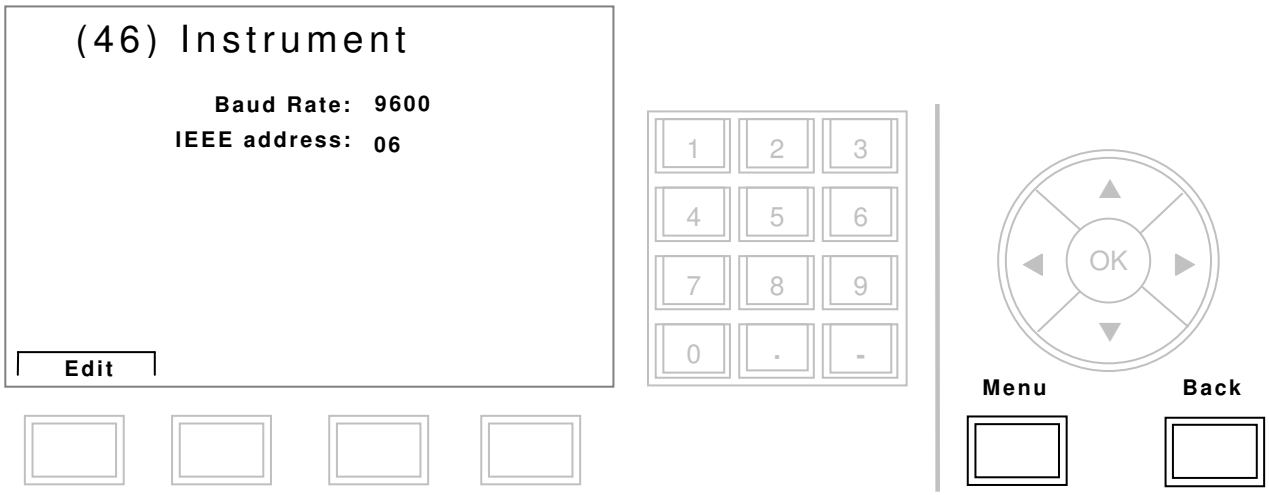
### 5.3.13 Presets menu

This menu is used to set the Baud rate[22] to 9600, 19200 or 38400. The menu is also used to set the address for the optional IEEE interface (when fitted).

Press the **4** key on the numeric pad and use the up and down keys to navigate to the System Menu and press the **OK** key to access this menu. Use the navigation key to move to the Presets menu as shown below.

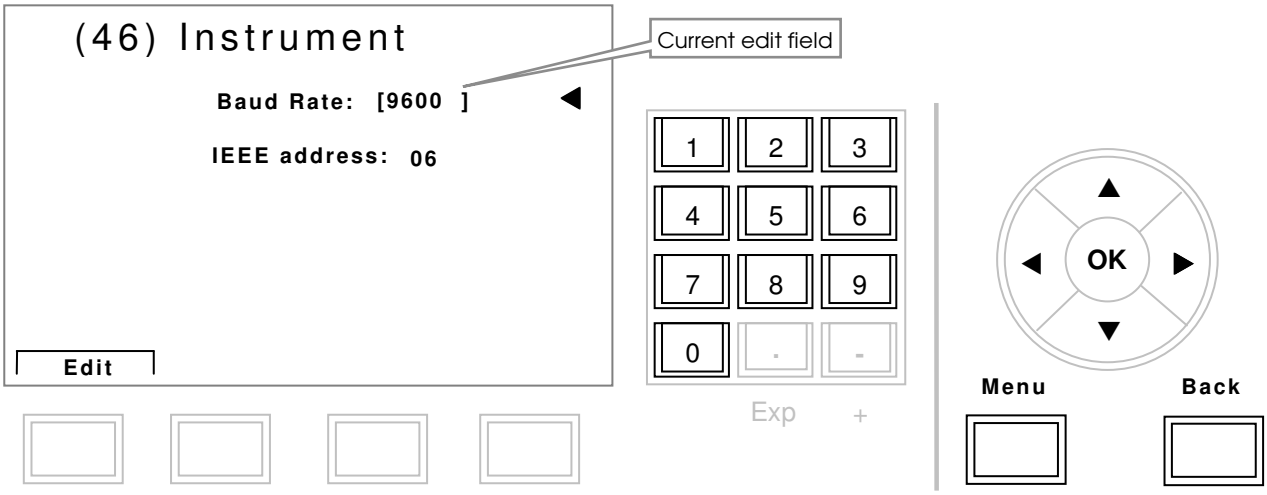



Press the **6** key or the **OK** key to see the current values –




[22] The default is 9600 baud.

Press the **Edit** soft-key to alter the value. The screen will change to show -




Editing is similar to the previous menus. Use the ▲ and ▼ navigation keys to move the active edit field. Move to the field that you want to change and press the ◀ and ▶ keys to alter the values within the field. The numeric keypad is used to enter the IEEE address.

Once you are happy with the entry, press the **Menu** key to return to measurement mode or press the **Back** key to return to the previous menu.

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# 6. Instrument Measurement Range

## 6.1 Instrument measurement working range

The instrument can detect the following conditions Open Circuit Probe, Over Range measurement and Under Range measurement. These conditions are shown by a message on the display.

## 6.2 Measurement ranges

| Measurement Units PRT | Conversion | Under Range | Over Range | Units |
|---|---|---|---|---|
| Resistance | None | 0 | 5,000 | ohms |
| Temperature | Din90 | -201 | +851 | °C, °F, K |
| | CvD | -201 | +850 | °C, °F, K |
| | ITS90 | -201 | +963 | °C, °F, K |


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# 7. Calibrating the F600

## 7.1 F600AC Instrument calibration

The F600AC bridge measurement technique used in the F600 is inherently very stable and linear. However a small drift of the internal reference resistor may occur with time, making periodic re-calibration advisable.

Check calibration daily before and after use with known, regularly-calibrated, reference resistors.

## 7.2 Equipment

Temperature controlled environment at +20°C ±2°C.

Set of stable, calibrated (0.01ppm) resistors (3 resistors).

## 7.3 Calibration procedure

See section 5.3.9.

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# 8. Obtaining the best from the F600AC bridge

## 8.1 Procedure

Please observe the following to obtain the best results from your instrument.

- ✓ Do ensure there are no draughts or forced air flow around the instrument (e.g. from an air conditioning unit).
- ✓ Allow at least 20 minutes for the instrument to fully stabilise if switching on from cold (when using the internal reference resistors).
- ✓ Do keep the operating environment stable.
- ✓ Do ensure the sensor leads and input connectors are free from dirt as leakage current will affect the results.
- ✓ Do ensure that you use an external, regularly calibrated reference resistance for your most accurate measurements[23].
- ✓ In common with best practice, use a known stable, calibrated resistor to take a measurement at the start and end of the day; log the results.
- ✓ Set the maximum current that your probe will stand without self-heating becoming an issue.

- × Do NOT locate the instrument near a source of vibration, heat, or draughts.
- × Do NOT locate the instrument near sources of electrical interference – e.g. electric motors.

[23] The F600AC Bridge contains high-quality and stable internal reference resistors, however these are only specified to an accuracy of ±0.01% with a thermal stability ±0.5 ppm/°C.

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# 9. Communications - Interface and PC commands

## 9.1 Introduction

The F600 is fitted with a USB communication interface as standard. The connected PC must have the correct USB driver installed to use the interface (see section 9.2). Alternatively, the F600 may be fitted with an RS232 or IEEE interface.

The commands are buffered by the F600 (saved in order of arrival) so more than one command can be sent to the instrument without waiting for the previous one to complete. However, it is normally easier to wait for the expected response before issuing the next one - especially when a response is expected.

## 9.2 Interfaces

The USB interface is fitted a standard. The (optional) IEEE or RS232 interface, while using a completely different means of transporting data, works in the same way as far as the command structure is concerned.

The specific difference between the data-transport methods are covered in the two sections below.

### 9.2.1 USB device driver

The USB PC interface will normally be installed as a virtual COM port driver (simulated serial port).

An interval of 1ms to 2 ms should be allowed between transmitted characters.

The communication protocol is –

| | |
|---|---|
| Bits per second | 9600 |
| Data bits | 8 |
| Stop bits | 1 |
| Parity | none |
| Flow control | none |

This baud rate may be changed at any time using the **Instrument Preset** screen.

Use the menu system on the CD to load the device driver; alternatively, run the program **CDM_Setup.exe** from the directory **D:\USB Drivers** on the CD supplied with the instrument[24]. This will install the USB drivers. You will see the following message once this is complete.

When writing a control program for the instrument, it may be easier to use the API commands provided by FTDI™. See their web-site for more details –

http://www.ftdichip.com/

### 9.2.2 IEEE-488.2 interface (optional)

The IEEE-488.2 interface[25] requires the instrument's bus address to correspond to the address used by the controller (normally a PC).

The IEEE interface uses an 8-bit data bus and software protocol to transfer data in parallel. Each instrument connected to the bus must have an unique address. This address may be changed at any time using the **Instrument Preset** screen. The F600 slave bus address has a default address of 6.

The software driver for the IEEE interface will be supplied by the PC interface card's vendor. A popular text based console program is supplied by National Instruments™ and an example of the use of this is shown below –

Win32 Interactive Control

Copyright 1996 National Instruments Corporation

All rights reserved.

Type 'help' for help or 'q' to quit.

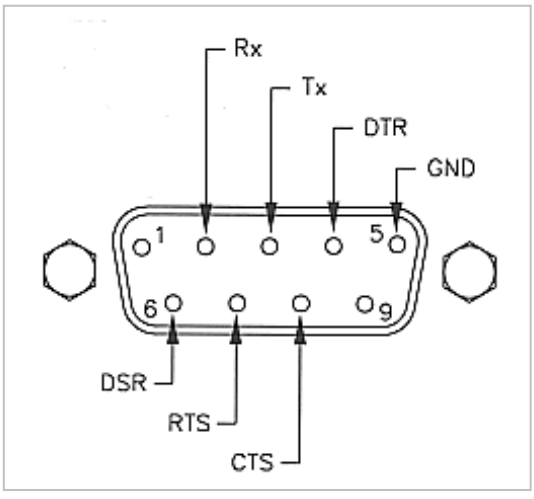
[24] Replace the '**D**' with the name of your CD device as necessary

[25] Also known as a GPIB interface

```
: ibdev
        enter board index: 0
        enter primary address: 6                    <<= Default for F600!!!
        enter secondary address: 0
        enter timeout: 13
        enter 'EOI on last byte' flag: 1
        enter end-of-string mode/byte: 10

ud0: ibwrt "CONF:GAIN?\x0D"                         <<= <CR> required i.e. \x0D
(0900)  ( rqs cmpl )                                <<= rqs also
count: 11

ud0: ibrd
        enter byte count: 6                         <<= line added unless you specify the
                                                    <<= number of byte top read it requests
(0900)  ( rqs cmpl )                                <<= Actual flags
count: 6
30  33  2c  30  31  0d          03,01.             <<= <CR> appears as a dot & is 0D hex

                                                    <<= plus ascii in lower case
```

### 9.2.3 RS232 interface (optional)

The RS232 interface uses a standard data lead to connect to a PC. Connections are as follows –



| Computer | Instrument | |
|---|---|---|
| 9-pin connector | Function | 9-pin connector |
| 2 | Rx | 2 |
| 3 | Tx | 3 |
| 4 | DTR | 4 |
| 5 | GND | 5 |
| 6 | DSR | 6 |
| 7 | RTS | 7 |
| 8 | CTS | 8 |

The F600 uses a basic RS232 interface, with 8 data bits, 1 start bit, 1 stop bit, and no parity. It is only necessary to connect pins 2, 3 & 5; handshaking is not implemented. The instrument has a female gender connector.

Baud rate is selectable (via the System Presets menu).

## 9.3 Instrument PC commands

The following sections apply equally to USB, RS232 and IEEE interfaces. The sections cover use of the remote PC commands. These may be sent to the instrument via a simple terminal program[26], through some programming interface, from Excel™ (or similar program) or interactively with a dedicated program (such as ULOG – supplied by ASL).

### 9.3.1 Remote mode (local lockout)

The instrument may be set into Remote mode to prevent problems with simultaneous control from a PC and from someone using the front panel keys. In Remote mode, the instrument can only be controlled over the interface since the F600's front panel keys are locked out. To enable Remote mode, the instrument must be sent a Remote mode command (see section 9.4.1).

It is not necessary to be in remote mode to use any of the PC commands, but care must be taken not to inadvertently change settings.

[26] A number of these are available free on the Web.

### 9.3.2 Programming command syntax

The programming command language is based on the SCPI command format. Commands consist of one or more command strings containing some or all of the following –

| | |
|---|---|
| Colon `:' | Separates command words |
| Question mark `?' | Command requiring a response |
| Space ` ` | Separates the command word from the first parameter (shown as <space> in the examples) |
| Comma `,' | Separates the parameters list |
| Parameter[27] <parameter list> | Parameters list separated by commas |
| Terminator <cr> | Terminates the line and the command |

For example, the current may be set by sending the string –

**CONF:CURR 2,3<cr>**

i.e. <command><:><command><space ><parameter><,><parameter><terminator(s)>

It is important to remember the space between the end of 'CURR' and the '2'.

### 9.3.3 Case sensitivity

Command words are not case sensitive; you can use upper or lower case characters or any combination. For example, the following are all valid –

SYSTEM:REMOTE

system:remote (or even SyStEm:rEmOtE)

### 9.3.4 Long form short form commands

Command words can have a long form and short form. The short form version is indicated by upper case characters in subsequent sections. Either form may be used. The following are identical –

[27] The '<' and '>' symbols in the text are used to help with clarity; they do not form part of the command sequence.

SYSTem:REMote (long form)

SYST:REM (short form)

### 9.3.5 Command terminators <cr> or <cr><lf>

All commands sent to the instrument must be terminated with a carriage return <cr> character. The terminating character pair <cr><lf> may also be used since the F600 ignores the <lf> character (for all types of interface). Receipt and response of the IEEE interface to a message (at the PC end) depend on the exact PC IEEE settings.

**Note**

The examples below assume that the IEEE interface is set to interpret the <cr> character sent from the F600 and output this as <cr><lf>.

For clarity, the command descriptions below (to the F600) do not use the <lf> character. Responses using the USB interface are shown [28].

### 9.3.6 Starting with PC commands

Experiment with the ***IDN?** commands when first starting and do not use the **SYSTEM:REMOTE** command until you are happy with the instrument's operation[29].

Use each of the commands in turn to confirm that they produce the response you expect from them.

[28] The exact response of the F600 IEEE interface will depend on the PC settings.

[29] The SYSTEM:REMOTE command is cancelled once the instrument's power is switched off and on again.

## 9.4 USB/IEEE/RS232 interface commands

All F600 commands are described in detail in the follow sections. Each command description follows a common layout.

### 9.4.1 SYSTem:REMote

**Command** SYST:REM
SYSTEM:REMOTE

**Returns** None

**Function** Places the instrument in remote mode for interface control
Displays 'Remote' on the F600
Aborts the current measurement cycle
Clears the last reading from the display
Clears the output buffer
Locks out the instrument's front panel keys

**Example** SYST:REM

### 9.4.2 SYSTem:LOCal

**Command** SYST:LOC
SYSTEM:LOCAL

**Returns** None

**Function** Returns the instrument to local mode
Removes 'Remote' from the instrument display
Enables the instrument's front panel keys

**Example** SYST:LOC

### 9.4.3 *IDN?

**Command** *IDN?

**Returns** <manufacturer>,<model no>,<serial no>,<firmware version>

**Parameters**

| | |
|---|---|
| <manufacture> | ASL |
| <model no> | F600AC |
| <serial no> | Serial number of the instrument |
| <firmware version> | Current firmware version and date |

**Function** Reads the instrument's identification code consisting of the manufacturer name, instrument model number, instrument serial number, firmware version and date

**Example**

| | |
|---|---|
| *IDN?<cr> | (command) |
| ASL,F600AC,00001003,1V0,30March2007<cr><lf> | (response) |

### 9.4.4 CONFigure:CURRent <multi>,<base>

**Command** CONF:CURR <multiplier>,<base>
CONFIGURE:CURRENT < multiplier >,<base>

**Returns** None

**Parameters**

| | | | |
|---|---|---|---|
| < multiplier > | 0 | Multiply by | 1 |
| | 1 | Multiply by | - |
| | 2 | Multiply by | ✓2 |
| <base> | 0 | Current set to | - |
| | 1 | Current set to | - |
| | 2 | Current set to | 100µA |
| | 3 | Current set to | 200µA |
| | 4 | Current set to | 500µA |
| | 5 | Current set to | 1.0mA |
| | 6 | Current set to | 2.0mA |
| | 7 | Current set to | 5.0mA |
| | 8 | Current set to | 10mA |

**Function** Selects the specified current without initiating a measurement

Aborts the current measurement cycle

Clears the last measurement from the display

Clears the output buffer

**Example** CONF:CURR<space>3,2<cr>
(sets the active channel's current to ✓2 x 100µA)

### 9.4.5 CONFigure:CURRent ?

**Command** CONF:CURR?
CONFIGURE:CURRENT?

**Returns** < multiplier >,<base> formatted to 2 significant digits

**Function** Returns the active channel's current setting

**Example** CONF:CURR?<cr> (command)
03,02<cr><lf> (response)
(returns the active channel's setting of ✓2 x 100µA)

### 9.4.6 CONFigure:GAIN <multiplier>,<base>

**Command** CONF:GAIN <multiplier>,<base>
CONFIGURE:GAIN <multiplier>,<base>

**Returns** None

**Parameters**

| | | | |
|---|---|---|---|
| < multiplier > | 0 | Multiply by | - |
| | 1 | Multiply by | - |
| | 2 | Multiply by | 1 |
| | 3 | Multiply by | 2 |
| <base> | 0 | Gain set to | - |
| | 1 | Gain set to | $1x10^1$ |
| | 2 | Gain set to | $1x10^2$ |
| | 3 | Gain set to | $1x10^3$ |
| | 4 | Gain set to | $1x10^4$ |
| | 5 | Gain set to | $1x10^5$ |
| | 6 | Gain set to | $1x10^6$ |

**Function** Sets the active channel's gain

**Example** CONF:GAIN<space>3,1<cr>
(sets the active channel's gain to 20)

### 9.4.7 CONFigure:GAIN?

**Command** CONF:GAIN?
CONFIGURE:GAIN?

**Returns** < multiplier >,<base><cr> formatted to 2 significant digits

**Function** Returns the active channel's gain setting

**Example** CONF:GAIN?<cr> (command)
03,01<cr><lf> (response)
(returns the active channel's gain settings of 20)

### 9.4.8 CONFigure:FILTer <filter>

**Command** CONF:FILT <filter>
CONFIGURE:FILTER <filter>

**Returns** None

**Parameters**

| | | | |
|---|---|---|---|
| <filter> | 0 | 0.1Hz |
| | 1 | 0.5Hz |
| | 2 | 1Hz |
| | 3 | 2Hz |
| | 4 | 5Hz |

**Example** CONF:FILT<space>4<cr>
(sets the filter to 5Hz)

### 9.4.9 CONFigure:FILTer?

**Command** CONF:FILT?
CONFIGURE:FILTER?

**Returns** <filter>

**Function** Returns the currently active channel's filter setting

**Example** CONF:FILT?<cr> (command)
01<cr><lf> (response)
(returns the active channel's filter setting of 5Hz)

### 9.4.10 CONFigure:AOUT <type>,<channel>,<scale>,<high>,<low>,<zero>

**Command** CONF:AOUT <type>,<channel>,<scale>,<high>,<low>,<zero>
CONFIGURE:AOUT <type>,<channel>,<scale>,<high>,<low>,<zero>

**Returns** None

**Parameters**

| | | |
|---|---|---|
| <type> | 0 | Measurement |
| | 1 | Balance (in manual mode) |
| <channel> | 0 to 99 | Which channel to apply to |
| <scale> | +/-1000 to 0.01 | Scale factor in units/volt |
| <high> | +10.0 to –10.0 | Maximum output in volts |
| <low> | +10.0 to –10.0 | Minimum output in volts |
| <zero> | Real or exp number | Value to offset the output in units |

**Function** Sets the analogue output parameters. Two modes of operation can be set. Either the output is based on the current unit measurement

***Output(V) = ( Measurement - Zero) * Scale***

or the error signal is output

***Output(V) = Error***

Note that the values of zero & scale are unit-less and will apply to the active channel's units - e.g. zero = 10.0, scale =100 will adopt the units of the instrument

**Example** CONF:AOUT<space>0,02,-10.0,+5.0,-5.0,1.0<cr>
Sets the analogue output voltage on channel 2 with a gain of x –10 symmetrically about 1.0 and limiting the output to +/-5V of full scale.

So if CH2 = 1.1, the analogue 1 output = -1.0V, and if CH2 = 0.75, the analogue 1 output = +2.5V

### 9.4.11 CONFigure:AOUT?

**Command** CONF:AOUT?
CONF:AOUT?

**Returns** <type>,<channel>,<scale>,<high>,<low>,<zero> formatted to 2 places

**Function** Returns the active channel's AOUT settings

**Example**

| | |
|---|---|
| CONF: AOUT?<cr> | (command) |
| 0,02,-10.00,+5.00,-5.00,1E01<cr><lf> | (response) |

(returns the active channels AOUT setting )

### 9.4.12 CONFigure:REFerence <source>,<channel>

**Command** CONF:REF <source>,<channel>
CONFIGURE:REFERENCE <source>,<channel>

**Returns** None

**Parameters**

| | | |
|---|---|---|
| <channel> | 0 to 99 | single channel measurement |
| <source> | INT | Internal |
| | EXT | External |

**Function** Sets the channel to use this reference type
Aborts the current measurement cycle
Clears the last measurement from the display
Clears the output buffer

**Example** CONF:REF<space>INT,01<cr>
(sets the selected channel's reference to internal 01 standard)

### 9.4.13 CONFigure:REFerence?

**Command** CONF:REF?
CONFIGURE:REFERENCE?

**Returns** <source>,<channel>

**Function** Returns the active channel's reference setting

**Example**

| | |
|---|---|
| CONF:REF?<cr> | (command) |
| I,01<cr><lf> | (response) |

(returns the reference for the active channel as Internal Ch01)

### 9.4.14 CONFigure:MODE <mode>,<test>

**Command** CONF:MODE <mode>,<test>
CONFIGURE:MODE <channel>,<test>

**Returns** None

**Parameters** F600 AC

| | | |
|---|---|---|
| <mode> | 0 | Place instrument in manual balance |
| | 1 | Place instrument in auto balance |
| <test> | 0 | Place instrument in normal measurement mode |
| | 1 | Place instrument in unity test mode |
| | 2 | Place instrument in zero test mode |

**Function** Selects the specified instrument measurement mode
Aborts the current measurement cycle
Clears the output buffer

**Example** CONF:MODE<space>1,0<cr>
(puts the instrument into the normal mode of operation)

### 9.4.15 CONFigure:MODE?

**Command** CONF:MODE?
CONFIGURE:MODE?

**Returns** <mode>,<test><cr>

**Function** Select the specified instrument measurement mode

**Example** CONF:MODE<space>1,0<cr>
Put instrument into auto with no test mode (i.e. normal operation)

CONF:MODE?<cr> (command)
0,0<cr><lf> (response)
(returns with the instrument's setting of manual & manual)

### 9.4.16 CONFigure:MSET <X.XXXXXX>,<U>

(Firmware version V2.6 onwards)

**Command** CONF:MSET <X.XXXXXX>,<U>

**Returns** None

**Parameter**

| | |
|---|---|
| X.XXXXXX | Numerical ratio to apply to the bridge |
| U | Units currently only `W` supported |

**Function** Set the ratio of the bridge in both Manual and Automatic mode (in Automatic mode, this ratio will exist briefly until automatic balance takes over).

**Example** CONF:MSET 0.345500,W<cr> (command)

**Errors** E03 – Incorrect parameter or invalid ratio

### 9.4.17 CONFigure: MSET?

(Firmware version V2.6 onwards)

**Command** CONF:MSET?

**Returns** X.XXXXXX,U<cr> Formatted balance value, where U is the unit

**Function** The current Manual bridge balance setting or the current Automatic balance value

**Example** CONF:MSET?<cr> (command)

1.002340,W<cr> (response)

**Errors** E03 – Ratio is currently invalid

### 9.4.18 MEASure:CHANnel <channel>

**Command** MEAS:CHANNEL <channel>
MEASURE:CHAN <channel>

**Returns** None

**Function** Sets the instrument to the active channel specified
Aborts the current measurement cycle
Clears the last measurement from the display
Clears the output buffer
Continues measuring with this channel's settings

**Example** MEAS:CHAN<space>23<cr>
(makes channel 23 the currently active channel)

### 9.4.19 MEASure:CHANnel?

**Command** MEAS:CHANNEL
MEASURE:CHAN

**Returns** Currently selected channel

**Function** Returns the currently selected channel

**Example** MEAS:CHAN?<cr> (command)
23<cr><lf> (response)
(returns with the active channel of 23)

### 9.4.20 MEASure:READ?

**Command** MEAS:READ?
MEASURE:READ?

**Returns** <measurement>,<units>,<flag>

**Parameters**

| | |
|---|---|
| <measurement> | last measurement value |
| <units> | current units for the active channel (see below) |

| | |
|---|---|
| C | Degrees Celcius |
| F | Degrees Fahrenheit |
| K | Kelvin |
| R | Resistance ohm's |
| W | Ratio |

| | |
|---|---|
| <flag> | B Balanced |
| | L too Low |
| | H too High |
| | Exx error state (see below) |

| Exx | Description |
|---|---|
| E01 | Invalid reading |
| E02 | Open probe |
| E03 | Reserved |
| E04 | Ratio over-range (exceeds maximum value of AC=4.99999 DC=9.999999) |
| E05 | Ratio under-range (less than minimum value of <0.0000000) |
| E06 | Ratio not a real value (i.e. divide by zero) |
| E07 | Reserved |
| E08 | Resistance over-range |
| E09 | Resistance under-range |

| | |
|---|---|
| E10 | Resistance does not compute to a real value |
| E11 | Reserved |
| E12 | Probe error |
| E13 | Invalid temperature calculation |
| E14 | Temperature above Limit |
| E15 | Temperature below Limit |

**Function** Returns the active channel's next measurement and settings

**Example**
MEAS:READ? <cr> (command)
0.999993, W,B<cr><lf> (response)
(returns the balanced ratio of 0.999993 for the active channel)

### 9.4.21 MEASure:FETCH?

**Command** MEAS:FETCH?
MEASURE: FETCH?

**Returns** <measurement>,<units>,<flag>

**Parameters** See MEASURE_READ?

**Function** Returns the active channel's current measurement and settings with the currently selected units. May be used to reread with different units

**Example**
UNIT:TEMP<space>CEL<cr> (command to set units to celcius)
MEAS: FETCH? <cr> (command)
203.456, C,B<cr><lf> (response)
(returns the balanced value of 203.456 °C for the active channel)

### 9.4.22 UNIT:TEMPerature <units>

**Command**
UNIT:TEMP <units>
UNIT:TEMPERATURE <units>

**Returns** None

**Parameters**

| | | |
|---|---|---|
| <units> | C or CEL | Degrees Celcius |
| | F or FAR | Degrees Fahrenheit |
| | K | Kelvin |
| | R | Resistance ohm's |
| | W | Ratio |

**Function** Sets the active channel's units.

**Example**
UNIT:TEMP<space>CEL<cr>
(sets the active channel's units to celcius)

### 9.4.23 UNIT:TEMPerature?

**Command** UNIT:TEMP?
UNIT:TEMPERATURE?

**Returns** <units><cr>

**Function** Returns the active channel measurement units
Change current display unit.

**Example**
UNIT:TEMP?<cr> (command)
C<cr><lf> (response)
(returns the active channel's units as celcius)

### 9.4.24 MEAS:READALL? or READALL?

**Command** MEAS:READALL?

**Returns** <Meas(W)>,<W>,<Meas(R)>,<R>,<Meas(C)>,<C>,<Meas(F),
<F>,<Meas(K),<K><cr>

**Function** Returns the next valid measurement for the active channel with all the conversion results

**Example**
MEAS:READALL?<cr> (command)
1.000079,W,100.0136,R,+0.035,C,+32.063,F,+273.185,K <cr><lf> (response)

**Errors** E00 – Unrecognised command.
E01 – Command is not parts of (MEAS:) series

### 9.4.25 PB:ID <nn>

**Command** PB:ID nn

**Returns** None

**Function** Selects local probe for editing

**Example**
PB:ID 05<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of the PB series
E02 – Missing parameter (i.e. nn)
E03 – nn exceeds allowable probe limit

**Notes** Probe ID 00 is not edittable. There is a limit of 100 probes that the system can hold

### 9.4.26 PB:ID?

**Command** PB:ID?

**Returns** nn<cr>

**Function** Returns the currently selected edittable probe number

**Example**

| | |
|---|---|
| PB:ID?<cr> | (command) |
| <05><cr><lf> | (response) |
| <??><cr><lf> | (response when probe not present) |

**Errors**
E00 – Unrecognised command
E01 – Command is not part of PB series
E03 – nn exceeds allowable probe limit

**Notes** There is a limit of 100 probes that the system can hold

### 9.4.27 PB:+ <nn>,<mm>

**Command** PB:+ nn,mm

**Returns** None

**Parameters** nn, mm

**Function** Add the probe to the unit and configures it for default parameters

**Example**

| | |
|---|---|
| PB:+ 05,05 | (command) |

**Errors**
E00 – Unrecognised command
E01 – Command is not part of PB series
E02 – Missing parameter (i.e. nn)
E03 – nn exceed allowable probe limit or nn is not equal to mm
E04 – nn already exists

**Notes** Probe ID 00 is not edittable. There is a limit of 100 probes the system can hold. The parameter is repeated for security

### 9.4.28 PB:- <nn>,<mm>

| | |
|---|---|
| **Command** | PB:- nn,yy |
| **Returns** | None |
| **Parameters** | nn, mm |
| **Function** | Delete the probe from unit |
| **Example** | PB:- 05,05 (command) |
| **Errors** | E00 – Unrecognised command<br>E01 – Command is not part of PB series<br>E02 – Missing parameter (i.e. nn,mm)<br>E03 – nn exceed allowable probe limit or nn is not equal to mm<br>E04 – nn already exists |
| **Notes** | Probe ID 00 is not edittable. There is a limit of 100 probes that the system can hold. The parameter is repeated for security |

### 9.4.29 PB:NM <sssssssssssss>

| | |
|---|---|
| **Command** | PB:NM sssssssssssss |
| **Returns** | None |
| **Parameters** | Probe string |
| **Function** | Sets the probe name |
| **Example** | PB:NM s/n 00123456 ASL<cr> (command) |
| **Errors** | E00 – Unrecognised command<br>E01 – Command is not part of PB series<br>E02 – Probe ID not valid<br>E03 – Missing parameter (i.e. sssssssssss)<br>E04 – sss parameter exceeds the maximum length |
| **Notes** | The maximum probe name string length is 31 characters |

### 9.4.30 PB:NM?

| | |
|---|---|
| **Command** | PB:NM? |
| **Returns** | The probe name as a string `sssssssssss' |
| **Parameters** | None |

**Function** Returns the probe name

**Example** PB:NM? <cr> (command)
PB:NM s/n 00123456 ASL<cr><lf> (response)

**Errors** E00 – Unrecognised command
E01 – Command is not part of PB series

**Notes** The maximum probe name string length is 31 characters

### 9.4.31 PB:WR <n>

**Command** PB:WR n
**Returns** None

**Parameters** Probe type

**Function** Sets the probe connection type

**Example** PB:WR 0<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of PB series
E02 – Probe ID not valid
E03 – Missing parameter (i.e. n)
E04 – n parameter value not valid

**Notes** Currently only 4 wire connection possible with this unit

### 9.4.32 PB:WR?

**Command** PB:WR?
**Returns** The probe connection type (0 = 4 wire, 1 = 3 wire)

**Parameters** None

**Function** Gets the probe connection type

**Example** PB:WR? <cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of PB series

**Notes** Reserved for future use. Currently only 4 wire connection is supported

### 9.4.33 PB:CV <n>

**Command** PB:CV n
**Returns** None

**Parameters** Probe type n –

0 = DIN
1 = CvD
2 = ITS90

**Function** Sets the probe temperature conversion type

**Example** PB:CV 2<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of PB series
E02 – Probe ID not valid.
E03 – Missing parameter (i.e. n)
E04 – n parameter value is not valid

**Notes** Parameter must be one of the above

### 9.4.34 PB:CV?

**Command** PB:CV?
**Returns** Probe temperature conversion type

**Parameters** None

**Function** Returns the probe temperature conversion type (see above)

**Example** PB:CV? <cr> (command)
<2><cr><lf> (response)

**Errors** E00 – Unrecognised command
E01 – Command is not part of PB series

### 9.4.35 PB:CF <m>,<+n.nnnnnE-ee>?

**Command** PB:CF m,+n.nnnnnE-ee

**Returns** None

**Parameters** Probe conversion value

**Function** Sets the probe temperature conversion parameter. See table below

| CFm | Din | Cvd | ITS90 |
|---|---|---|---|
| CF**0** | R0 | R0 | R0.01 |
| CF**1** | A | A | AP |
| CF**2** | B | B | BP |
| CF**3** | C | C | CP |
| CF**4** | | | DP |
| CF**5** | | | AN |
| CF**6** | | | BN |
| CF**7** | | | W |

**Example** PB:CF3 –4.183000E-12<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of PB series
E02 – Probe ID not valid
E03 – Missing parameter (i.e. +n.nnnnnE-ee)
E04 – +n.nnnnnE-ee parameter value not valid

**Notes** The parameter +n.nnnnnE-ee is limited to between –1E-50 and +1E+50

### 9.4.36 PB:CFn?

**Command** PB:CFn?

**Returns** The probe temperature conversion parameter n

**Parameters** None

**Function** Returns the probe temperature conversion parameter n. See previous command for details

**Example** PB:CF3? <cr> (command)
–4.18299999E-12<cr><lf> (response)

**Errors** E00 – Unrecognised command
E01 – Command is not part of PB series (ie CFn)
E02 – Probe ID not valid

**Notes** The parameter +n.nnnnnE-ee is limited to between –1E-50 and +1E+50

### 9.4.37 CH:ID <nn>

**Command** CH:ID nn
**Returns** None

**Parameters** nn

**Function** Select local channel nn for editing

**Example** CH:ID 17<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of CH series
E02 – Missing parameter (ie nn)
E03 – nn exceed allowable channel limit

**Notes** Channel 00 is not edittable. There is a limit of 100 channels that the system can hold

### 9.4.38 CH:ID?

**Command** CH:ID?
**Returns** nn<cr>

**Parameters** None

**Function** Returns the currently selected edittable probe channel

**Example** CH:ID?<cr> (command)
17<cr><lf> (response)

**Errors** E00 – Unrecognised command

E01 – Command is not part of CH series

**Notes** Channel 00 is not edittable. There is a limit of 100 channels that the system can hold

### 9.4.39 CH:TY?

**Command** CH:TY?

**Returns** None or n<cr>

**Parameters** None

**Function** Returns Channel type either Rt or Rs for the selected channel
0 – Rt (Normal channel)
1 – Rs (External reference resistor channel)

**Example**

| | |
|---|---|
| CH:TY?<cr> | (command) |
| 1<cr><lf> | (response) |
| ??<cr><lf> | (response if channel not present or valid) |

**Errors** E00 – Unrecognised command
E01 – Command is not part of CH series

### 9.4.40 CH:RT:+ <nn>,<mm>

**Command** CH:RT:+ nn,mm

**Returns** None

**Parameters** nn, mm

**Function** Add channel (channel 0 setting are copied) nn = mm for security
0 – Rt (Normal channel added)
1 – Rs (External reference resistor channel added)

**Example** CH:RT:+ 13,13<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of CH series
E02 – Missing parameter (i.e. nn,mm)
E03 – nn exceed allowable probe limit or nn is not equal to mm
E04 – Channel nn already exists.
Note: Channel 00 is not edittable. There is a limit of 100 channels the system

**Notes** Channel 00 is not edittable. There is a limit of 100 channels that the system can hold

### 9.4.41 CH:RT:- <nn>,<mm>

**Command** CH:RT:- nn,mm

**Returns** None

**Parameters** nn,mm

**Function** Delete channel nn == mm (for security)

**Errors**
E00 – Unrecognised command
E01 – Command is not part of CH series
E02 – Missing parameter (i.e. nn,mm)
E03 – nn exceed allowable probe limit or nn is not equal to mm
E04 – Channel nn doesn't exist.
E05 – Channel is type Rs (not Rt)

**Notes** Cannot delete Channel 00. If the channel to be deleted is currently selected for measurement then on deletion this will be changed to channel 0

**Example** CH:RT:- 13,13<cr> (command)

### 9.4.42 CH:RT <Ii>,<Gg>,<U>,<amm,PP>

**Command** CH:RT Ii,Gg,U,amm,PP

**Returns** None

**Parameters** See tables below

**Function** Sets the Rt channel setting based on the following

**Errors**
E00 - Unrecognised command
E01 – Selected channel is not valid
E02 - Command is not part of CH series
E03 -Channel is not of type Rt
E04 - Too many/few parameters (should be 5)
E05 - Ii: 1st parameter (Ii ) error
E06 - Gg: 2nd parameter error
E07 - U: 3rd parameter error
E08 - Rs 4th parameter Exceeds Number of reference channels
E09 - Rs 4th parameter Channel does not exist or channel is not of type Rs
E09 - PP 5th parameter Exceeds Number of probes possible
E10 - PP 5th parameter Probe number does not exist.

**Notes** The parameters used combined value in some case

**Example** CH:RT 25,31,C,I01,03<cr> (command)
(Set Icc = 1.4mA, gain 20, celcius, internal Rs Ch01, probe 03)

U – Units

| U | Units |
|---|---|
| w | Ratio |
| R | Ohms |
| C | Celcuis |
| F | Fahrenheit |
| K | Kelvin |

amm – Reference channel

| a | mm | Type |
|---|---|---|
| I | 01 to 99 | Internal |
| E | | External |
| | | Channel number |

Ii – combined current value

Gi – Current combined ident (see table below)

| Parameter | I | i |
|---|---|---|
| multiply x 1 | 0 | |
| multiply x 0.5 | | |
| multiply x √2 | 2 | |
| 10uA | | 0 |
| 20uA | | 1 |
| 100uA | | 2 |
| 200uA | | 3 |
| 500uA | | |
| 1.0mA | | 5 |
| 2.0mA | | 6 |
| 5.0mA | | |
| 10.0mA | | 8 |

Gg – Gain combined

| Parameter | G | g |
|---|---|---|
| x 0.4 | | |
| x 0.8 | | |
| x 1.0 | 2 | |
| x 2.0 | 3 | |
| $1x10^0$ | | |
| $1x10^1$ | | 1 |
| $1x10^2$ | | 2 |
| $1x10^3$ | | 3 |
| $1x10^4$ | | 4 |
| $1x10^5$ | | 5 |
| $1x10^6$ | | 6 |
| $1x10^7$ | | 7 |

### 9.4.43 CH:RT?

**Command** CH:RT?

**Returns** Channel settings for currently selected channel

**Parameters** None

**Function** Returns the Rt channel setting based on the tables (see table in the previous command)

**Errors** E00 - Unrecognised command
E02 - Command is not part of CH series
E03 -Channel is not Rt

**Example** CH:RT? <cr> (command)
CH:RT 25,31,C,I01,01<cr><lf> (response)
(root(2)x1mA, gain x20, celcius, internal Rs 01, probe 01)

### 9.4.44 CH:RS:+ <nn>,<mm>

**Command** CH:RS:+ nn,mm

**Returns** None

**Function** Adds external reference channel (channel 0 setting are copied). The value nn = mm for security

**Example** CH:RS:+ 08,08<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of CH series
E02 – Missing parameter (i.e. nn,mm)
E03 – nn exceed allowable probe limit or nn is not equal to mm
E04 – Channel nn already exists

**Notes** Channel 00 is not edittable and is always Rt. There is a limit of 100 channels that the system can hold

### 9.4.45 CH:RS:- <nn>,<mm>

**Command** CH:RS:- nn,mm

**Returns** None

**Function** Deletes reference resistor channel nn (confirmed as mm for security)

**Example** CH:RT:- 08,08<cr> (command)

**Errors**
E00 – Unrecognised command
E01 – Command is not part of CH series
E02 – Missing parameter (i.e. nn,mm)
E03 – nn exceed allowable probe limit or nn is not equal to mm
E04 – Channel nn doesn't exist.
E05 – Channel is type Rt not Rs

**Notes** If the unit has the channel to be deleted selected for measurement then, on deletion, this will be changed to channel 0.

### 9.4.46 CH:RS:E <n.nnnnnnE+ee>

**Command** CH:RS:E n.nnnnnnE+ee

**Returns** None

**Function** Sets the value of the externally select channels reference resistor. The channel selected MUST BE of type Rs

**Example** CH:RS:E 1.001000E+02<cr> (command)

**Errors** E00 – Unrecognised command
E01 – Command is not part of CH series
E02 – Channel select is not of Type RS (see CH:TY command)
E03 – Missing n.nnnnnE+ee parameter
E04 – n.nnnnnE+ee exceeds limits ( <0.1 or >1E+8 )

### 9.4.47 CH:RS:In?

**Command** CH:RS:In?

**Returns** n.nnnnnnnE+ee<cr>

**Function** Returns the internal resistor's calibration value (see table below)

| n | F600 |
|---|---|
| 0 | 25R value |
| 1 | 100R value |

**Example** CH:RS:I1?<cr> (command)
99.99987<cr><lf> (response)

**Errors** E00 – Unrecognised command
E01 – Command is not part of CH series or n exceeds value for unit

# 10. Options and Accessories

## 10.1 Accessories

The following options are available for the F600 –

| Part Number | Description |
|---|---|
| FA-1 | 1 pair coaxial leads, BNC to BNC, 3 metres long |
| FA-2 | 1 pair coaxial leads BNC to open end, 3 metres long |
| FA-3 | 1 adaptor box (BNC to terminal and BNC) |
| FA-4 | 2 Terminal Binding Post to BNC (2 off) |
| T25-650-1 | Standard reference PRT $R_o$ = 25.5 ohms (nominal). 2 metre cable 4 wire plus screen with spade terminal connections. Stem length 450mm, quartz. R100/$R_o$ 1.3925 (minimum). Reproducibility 0.01K or better. Range -189 °C to +650 °C. |
| T100-650-1 | Physically similar to T25-650-1, but with $R_o$ = 100 + 0.05 ohms. Suitable for use in laboratory environments, but not for general industrial applications. Range -189 °C to +650 °C |
| T25-660-1 | Secondary transfer standard PRT 25.5 ohm 4 wire with 4 metres connecting cable to spade terminals. Range 0 °C to +650 °C. |
| T100-450-2 | Working reference PRT $R_o$ = 100 ohms, 2 meter cable with spade terminals. Stem length 450mm stainless steel with quartz liner. Range -100 °C to +450 °C. Alpha = 0.00385. |
| T100-450-3 | As T100-450-2 except Alpha = 0.00392. |
| T100-600 | Working reference PRT $R_o$ = 100 ohms, 2 meter cable with spade terminals. Stem length 460mm quartz. Range -50 °C to +600 °C. Alpha = 0.00385. |
| T0.25-962-1 | High Temperature standards PRT. $R_o$= 0.25 ohms. Range up to 962 °C |
| SB148 | 10 channel automatic/remote scanner. Current source for unselected PRTs. |
| FR4 | Four, oven controlled reference resistors for systems applications. 1, 10, 25 & 100 ohms. |
| RW | Oil filled Standards resistors. 1, 10, 25, 100 & 1000 ohms |
| RR | Laboratory Reference Resistors. 1, 10, 25, 100 & 1000 ohms |
| RTE | Thermal enclosure for RW & RR resistors. |

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# 11. Specifications

## 11.1 Resistance thermometer measurement[30]

| | |
|---|---|
| PRT characterisation | ITS90, Din90 BS EN60751:1996, IEC60751:1983 |
| | CvD BSEN1904:1984, IEC751:1983 |
| Ratio range | 0 to 4.999999 |
| Resistance measurement range | 0 to 500 ohm |
| Temperature measurement range | ITS90 -200 to +962ºC |
| | Din90 -200 to +850ºC |
| | CvD -150 to +850ºC |
| Display resolution | 1ppm, 0.1 mK |
| Accuracy (ratio)[31] (+20°C ±5°C) | ±2ppm |
| Accuracy (resistance) (+20°C ±5°C) | ± 0.2mΩ |
| Accuracy (temperature) (+20°C ±5°C) | ± 0.5mK at 273K, ± 2.5mK full range |
| Sense current | 10µA, 20µA, 100µA, 200µA, 1mA, 2mA, 10 mA |
| Sense current multipliers | 0.5 and √2 |
| User selectable measurement display | Ratio, ºC, ºF, K or ohms |
| Internal reference resistors | 25Ω , 100Ω |
| Internal reference resistors thermal stability | ± 0.5ppm/°C |
| Internal reference resistors accuracy | ± 0.01% (uncalibrated) |
| Input channels | 1 PRT + 1 reference resistor |
| Input connection | 4 x BNC + shield |
| Interfaces (optional) | IEEE, RS232C |
| Expansion port (optional) | 1 x SB148 |

## 11.2 Display

| | |
|---|---|
| Vacuum Fluorescent Display (VFD) | 256 x 128 (adjustable brightness) |

[30] Measurements do not include uncertainties to the sensor.

[31] Using 100Ω, 1mA current, x4 gain, external reference, medium adaptive filter and a 2 second update rate.

## 11.3 Analogue outputs

| | |
|---|---|
| Output 1 | ±10V dc, 10 mA. Function is range dependent |
| Output 2 | ±10V dc, 5 mA (1 Hz bandwidth) |

## 11.4 Power supply

| | |
|---|---|
| Mains charger supply voltage range | 90Vac – 264Vac |
| Power consumption | 95VA max |
| Supply frequency range | 47Hz - 63Hz |
| Fuse | T3A 250 Vac (slow blow) |

## 11.5 Environmental

| | |
|---|---|
| Storage temperature range | -20ºC to +50ºC |
| Service temperature range | +15ºC to +35ºC |
| Specified operating temperature range | +15ºC to +25ºC |
| Operating relative humidity conditions | < 80% RH, non-condensing |

## 11.6 Dimensions and weight

| | |
|---|---|
| Dimensions | 150 x 455 x 450 (h x w x d) |
| Weight | 9 kg |

The F600 has been designed to comply with current standards and safety legislation. The instrument complies with IEC61010-1 and conforms to the low-voltage and EMC directives.

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# 12. Cleaning and Maintenance

## 12.1 Cleaning

Make sure the F600 is disconnected from any leads and from the mains supply before cleaning.

Clean the outside of the instrument with a soft, clean cloth, slightly dampened with mild detergent. Do not allow water to enter the instrument.

**Warning**

Never use alcohol or thinners as these will damage the instrument.

Never use a hard or abrasive cloth or brush.

Always disconnect from the mains supply before cleaning.

**Warning**

Regularly inspect the mains cable and plug for damage.

## 12.2 Maintenance

Keep the instrument and its leads clean with occasional calibration checks. In particular the connectors to the $R_t$ and $R_s$ terminals should be kept clean to prevent leakage currents flowing. Damaged cable and connectors are a common cause of poor and intermittent operation.

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# 13. Service and Warranty

F600 instruments and accessories, (unless stated otherwise), are covered by a 12 month warranty on parts and labour from the date of dispatch from ASL (provided the instrument has not been damaged in use or tampered with). This warranty does not include costs incurred in returning the equipment to the factory for repair.

## 13.1 Technical Support

For all technical support, repair, warranty and service inquiries please contact:

Technical Services
ASL
2 Gatton Business Park
Wells Place
Redhill
Surrey RH1 3LG
ENGLAND
United Kingdom.

Telephone: +44 (0) 1737 649300
Fax: +44 (0) 1737 649301

E-Mail: service@aslltd.co.uk

Web Page: www.aslltd.co.uk

# 14. Appendix 1 – Firmware update

## 14.1 Firmware updates

ASL may decide to provide firmware updates from time to time. These can be downloaded from the ASL website www.aslltd.co.uk. The procedure for updating the F600 is described in detail below. A PC, downloader software[32] and USB cable are required.

## 14.2 Firmware update disclaimer

It is entirely your choice whether you choose to apply these firmware updates to your instrument. ASL, whilst taking the utmost care to thoroughly test both the firmware and the update procedure, can not accept any responsibility for any problem or loss resulting from the procedure

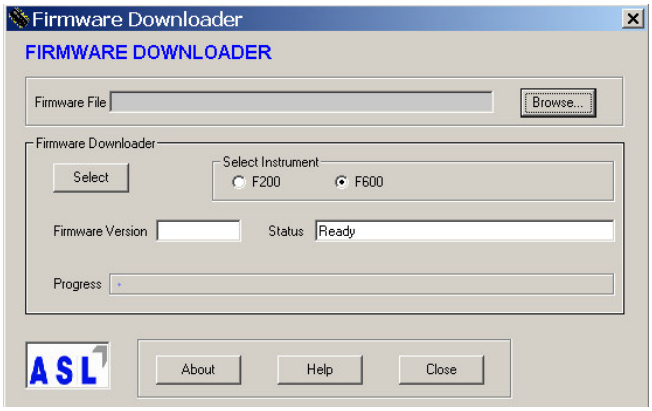
During the download, the process will overwrite the internal F600 memory. This may cause random characters to appear on the display and the position of these characters on the display may change. Both conditions are quite normal and will not affect the download.

## 14.3 Firmware update procedure

- Obtain a copy of the latest firmware from the ASL website www.aslltd.co.uk and copy the file into the directory indicated by the instructions on the website.
- Run the program **CDM_Setup.exe** from the directory **D:\Downloader** (replace the '**D**' with the name of your CD device if necessary). This will install the USB drivers. You will see the following message one this is complete (Only required when the USB interface is fitted).

[32] Provided on the CD with the instrument.

- Install the downloader software on your PC by running the program **INSTALL.EXE** from the directory **D:\Downloader** (replace the '**D**' with the name of your CD device if necessary). Follow the installation procedure instructions which require you to enter your name and the name of your company[33].
- This will create a shortcut icon on the desktop called ASL Downloader. Click on the ASL downloader icon to run the downloader program. Select the F600 Instrument option
- Click on the Help button.




- Read the instructions and follow the instructions provided to update the instrument's firmware.

[33] The same download program can be used to update F200 firmware.

# 15. Appendix 2 – Callendar van Dusen

## 15.1 Callendar van Dusen equation (CvD))

Platinum Resistance Thermometers (PRTs) are one of the most linear temperature sensors that we have. Even so, the relationship between resistance and temperature is not entirely linear and so it is necessary for the conversion from resistance to temperature to allow for this.

The IEC751 standard provides an equation that can be used to convert resistance to temperature taking into account the small non-linearities of the PRT –

$$R_t = R_o\left[1 + At + Bt^2 + C(t-100)t^3\right]$$

Where '$R_t$' is the resistance at temperature '$t$' and '$R_0$' is the resistance at 0°C. The coefficients *A*, *B* and *C* (*C* = 0, if *t* > 0 °C ) are defined in IEC751 for standard PRTs. However, the coefficients must be measured individually (by regression) for a particular PRT when greater accuracy is required.

An alternative (and easier) method exists via the Callendar van Dusen (CvD) equation, based on measurement of four accurately known temperatures. The F600 allows these coefficients to be entered for each probe used. The resistance to temperature conversion calculation is then carried out automatically within the instrument. However, this does rely on the user knowing the coefficients A, B and C accurately and entering these into the F600.

It is worth noting that the coefficients vary between standards. Typical values (PRT dependent) are –

| Standard | α | A | B | C |
|---|---|---|---|---|
| DIN 43760 | 0.003850 | $3.9080 \times 10^{-3}$ | $-5.8019 \times 10^{-7}$ | $-4.2735 \times 10^{-12}$ |
| ASTM | 0.003911 | $3.9692 \times 10^{-3}$ | $-5.8495 \times 10^{-7}$ | $-4.2325 \times 10^{-12}$ |
| ITS-90 | 0.003926 | $3.9848 \times 10^{-3}$ | $-5.870 \times 10^{-7}$ | $-4.0000 \times 10^{-12}$ |
| | | | | C= 0 if t > 0°C |

# 16. Appendix 3 - ITS-90

## 16.1 International Temperature Scale (ITS-90)

The purpose of this scale is to define procedures by which certain specified practical PRTs of the required quality can be calibrated in such a way that the values of temperature obtained from them can be precise and reproducible; at the same time matching the corresponding thermodynamic values as closely as current technology permits. Since 1968 when the IPTS68 was adopted, there have been significant advances in the techniques employed in establishing temperature standards and in the measurement of thermodynamic temperature.

The ITS-90 scale has much improved continuity, precision and reproducibility compared with IPTS68. The implementation of the ITS-90 scale according to its definition calls for significant changes in equipment and procedure compared with IPTS68, but lower uncertainties of calibration are achievable in all parts of the range. However, the instruments and equipment needed to implement the ITS-90 scale in calibration laboratories will be substantially the same. Particular features are –

ITS-90 specifies the use of the PRT up to the freezing point of silver, 961.78 °C. The platinum 10% rhodium/platinum thermocouple is no longer specified for use in the scale, though it and other noble metal thermocouples will continue to be used as secondary standards[34].

- New, more precise, fixed points have been introduced and mathematical procedures for calculating resistance/temperature equivalents have been revised so as to reduce the 'non-uniqueness' of the scale: that is, to reduce the differences which occur between different, identically calibrated PRTs. In particular, the calibration of a PRT can no longer be extrapolated beyond the freezing point of zinc, 419.527 °C, but requires a measurement at the freezing point of aluminium, 660.323 °C.

- Alternative definitions are permitted in certain sub-ranges, so that the calibration of a PRT can be terminated at almost any fixed point. This provision allows primary calibrations to be carried out with suitable PRTs over reduced ranges,

[34] Note that each of these fixed points has an uncertainty associated with it.

and will be of special importance to metrology standards departments which need to make precise measurements at ambient temperatures.

- The part of the ITS-90 scale which may be measured by PRTs extends from 83.8058 K (-189.3442 °C) to 961.78 °C. The actual range of temperatures which may be measured depends on the type and range of the PRT used.

The ITS-90 scale requires the entry of 6 constants into the F600 before the instrument can accurately convert resistance to temperature for a particular PRT.

The constants are conventionally called $R_{0.01}$, *Ap, Bp, Cp, Dp, An, Bn* and *W*.

# 17. Appendix 4 - DIN standard

### 17.1 DIN 43760 1980 (IEC 751)

The DIN standard uses defined values for the conversion of resistance to temperature using the Callendar van Dusen equation. No data entry for the probe is required since the coefficients are predefined. The DIN coefficients are defined as –

$R_0$ = 100 ohms

A = $3.90823 \times 10^{-3}$

B = $-5.7750 \times 10^{-7}$

C = $-4.183 \times 10^{-12}$

The F600 will provide accurate resistance to temperature conversion based on these values when DIN conversion is selected for a probe.

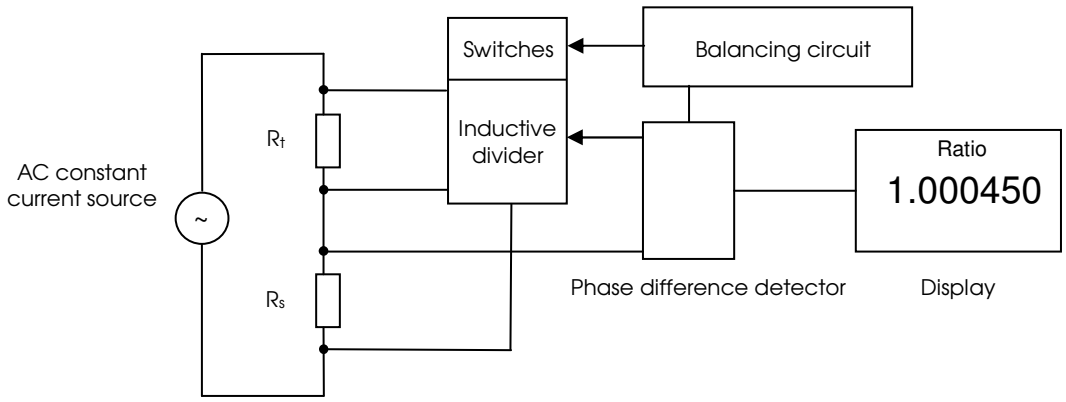
# 18. Appendix 5 – AC Bridge operation

## 18.1 AC Bridge basics

Although the principle of measuring the ratio of two resistors (see introduction) is identical between AC and DC bridges, the bridges operate very differently in the way they perform this ratio measurement.

DC bridges require very stable and accurate electronics to achieve their performance; AC bridges do not require such high-stability. Since they are based on an AC measurement, these bridges are also immune to all thermal problems associated with DC bridges.

The basic bridge arrangement is shown below –




The AC constant current source generates a 25Hz sine-wave that supplies $R_t$ and $R_s$ in series - so both resistors see identical currents[35].

The inductive divider consists of numerous turns of wires round transformer cores. The turns are arranged so that they form a series of ratio dividers that can be individually switched in and out by the balancing circuit.

The bridge works by balancing the inductive dividers (using the phase difference detector) so that the ratio of currents in the two series resistors is precisely known and equal to their ratio. Since the balance point depends only on the ratio of the transformer turns to the unknown resistance, the measurement is precise and unaffected by drift.

[35] The frequency is automatically adjusted to 30Hz when the mains power supply runs at 60Hz; this eliminates mains interference since the generated sine-wave is locked to the mains supply frequency.

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